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OBITUARY

JOHN L. WILTSHIRE

Born 21st November, 1905; Died 13th November, 1934

It is with deep regret that we have to record the death of Dr. J. L. Wiltshire, M.Sc. (Lond.) PH.D. (Lond.) F.I.C., on the 13th November, as the result of a motor accident. He entered the service of the Institute as a member of the Chemical Division on the 11th September, 1931.

Dr. Wiltshire, who was born on the 21st November, 1905, came to Malaya with an excellent academic and research record and his work on latex and raw rubber gave promise of still further enhancing his reputation as an investigator.

He obtained the degree of B.Sc. (London Univ.) in 1925 obtaining second class Honours in Chemistry.

In 1927 he was awarded the M.Sc. degree of his University for research on anthracene derivatives, while in 1930 he was awarded the PH.D. of the London University for a thesis embodying the results of further research.

He obtained the Associateship of the Institute of Chemistry of Great Britain and Ireland in 1927 and was elected a Fellow of the Institute in 1930.

Previous to coming to Malaya he was a pupil with a well-known firm of Consulting Chemists and Metallurgists, and later was engaged in research with a well-known firm of Tar Distillers, first as Assistant and later as Chief Chemist of the Works Laboratory.

Immediately before taking up his appointment in Malaya he was engaged in research at the Fuel Research Station of the Department of Scientific and Industrial Research.

He had published a number of papers in various scientific journals on the results of original research and since his arrival in Malaya has contributed to the Journal of the Institute and also written a Bulletin containing the results of investigations on clonal latex and rubber on which work he was still engaged.

At the Annual Conference of the Incorporated Society of Planters in 1933, he shewed his capacity as a lecturer.

He was a member of the Light Battery of the F.M.S.V.F. in which he took a very keen interest.

By his death the Institute and the rubber industry in Malaya has lost a valuable investigator while his colleagues have also lost a very genial co-worker and friend.

EDITORIAL

TAPPING EXPERIMENTS

The paper by Mr. Sharp entitled "Experiments with economic Tapping Systems" gives results of the first year's tapping of a long-range experiment with various systems of tapping mature seedling rubber.

Arrangements have been made to continue this experiment for a minimum period of five years. The experiment has been laid down in accordance with modern technique of field experiments in order that the results may be analysed by statistical methods to increase considerably the reliability of the conclusions reached.

In modern tapping systems there is a very definite tendency to adopt some form of periodic tapping and resting but little or no information is available as to the most suitable periods of tapping and resting. In the experiments described, several variations have been included in order to obtain information on this point.

The experiment also includes double-cut systems which are more economical in respect of tapping costs. As will be seen from the results, the double-four system, during the first year of tapping, shows no loss of crop compared with the single-cut alternate-daily system, but effects a saving of 25 per cent in tapping costs.

In addition to this large experiment which is under the direct control of the Institute, records are being obtained from other estates, on which experiments are being carried out in accordance with recommendations as to lay-out made by the staff of the Botanical Division of the Institute. Other experiments will shortly be commenced on young rubber at the Institute Experiment Station so that in due course more information will be available on this important subject.

NOTES ON A TAPPER'S WORKING TIME

In order to effect economies in various processes and to accelerate output in modern factories, studies have been carried out of the various motions concerned in the conduct of a particular series of operations, so that wasteful or unnecessary effort may be eliminated or reduced.

In the short paper presented under the above title, Mr. Sharp discusses the time occupied in the operations involved in tapping and collection of latex from the tree in relation to the time

occupied by walking between the tasks. A study of these factors is of importance in relation to the size of the tapper's task and the system of tapping and indicates how economies can be effected.

OIDIUM HEVEAE LEAF DISEASE

It is intended each year to publish a record with any useful observations of outbreaks of leaf disease caused by the fungus—*Oidium Heveae*—in various districts throughout the peninsula. In this number of the *Journal* Mr. Beeley describes the outbreak which occurred during the early part of the present year.

Generally, it may be stated that the outbreak was widespread and that information of infected trees was received from all parts of the country. It is not, however, possible to state whether the larger number of reports of infections during 1934 are due to the leaflets sent to all estates early in the year, requesting reports or suspected materials to be sent to the Institute for confirmation. As Mr. Beeley states, the general distribution of the fungus throughout Malaya has been known for some years, but infections on individual estates may have been overlooked previously when the attack was only slight.

The weather conditions after the wintering season, however, were generally favourable to the disease and this, combined with the request made to estate managers to report the occurrence of suspected presence of the disease, resulted in a large number of reports being received.

The general weather conditions rendered the recommended treatment by sulphur dusting difficult to carry out on those estates on which the attacks were sufficiently severe to warrant treatment. Further difficulties also arose in connection with the importation of an unsatisfactory grade of sulphur and the unreliability of a number of the dusting machines used. Arrangements have been made which it is anticipated will result in the sale of a more suitable type of sulphur. Experiments are also being carried out with the object of producing a more suitable dusting machine.

Circulars have been issued to various agency houses and managers of estates in regard to the methods and cost of treatment. From these and previous publications in the *Institute Journal* managers of estates should be well acquainted with the procedure to be adopted if a severe outbreak necessitating sulphur dusting occurs after the next wintering season.

The attention of all managers is invited to the separate leaflet issued with this *Journal* in regard to any outbreak or suspected infection during the next period of refoliation.

COAGULATION OF ALKALINE LATEX

Latex as it issues from the tree is normally neutral, that is neither acid nor alkaline, and coagulation is effected by means of the addition of acids. Alkaline substances not only inhibit coagulation but their presence in the latex necessitates the addition of abnormal amounts of acid to effect subsequent coagulation.

The coagulation of an alkaline latex is of importance in relation to ammoniated latex which may be found unsuitable for direct application on account of discolouration or some other defect, and also in relation to the coagulation of the dilute skim latex produced in the centrifugal process for the concentration of ammoniated latex.

Although experiments are being carried out with the object of finding substances other than ammonia which can be used for the preservation of latex in the liquid state, to date ammonia appears to be more effective than many powerful bactericides.

In addition, rubber having specific properties, such as increased plasticity, may possibly be obtained by the use of a non-acid coagulant which will effect the coagulation of an alkaline latex.

The article by Mr. Hastings describes experimental work on the coagulation of alkaline latex. It is not possible at present to prescribe a formula which can be applied to all cases since the coagulation of alkaline latex appears to vary under different conditions. It is therefore essential in dealing with ammoniated skim latex to carry out trials with a particular latex in order to ascertain the most suitable conditions for effective coagulation, before applying the formula to a large quantity of the bulked product.

If the process described is found to result in a rubber having specifically desirable properties, it can be applied under controlled conditions of alkalinity and dilution of the latex.

PACKING OF RUBBER

One method of effecting further economies in the marketing of raw rubber is the substitution of some equally effective but cheaper container than the plywood boxes at present used for packing rubber for export.

The adoption of alternative packing materials is a matter for producers' organizations, the Rubber Trade Associations in the various buying centres and the rubber manufacturers, although it is a problem for investigation by a research organization such as this Institute in relation to the possible value of various packing materials and treatment of the raw rubber for the prevention of contamination.

Considerable interest has been evinced in the problem recently, judging from the reports published in various technical journals relating to trial shipments of rubber packed in paper bags. In these shipments the individual sheets of rubber were dusted with a lubricating powder in order to prevent massing during shipment and storage so that the smaller manufacturers with no facilities for separating or cutting the massed product could separate the sheets.

The manufacture of a strong paper bag of the requisite capacity and the proposed manufacture of a ply-paper using latex as an adhesive have also stimulated interest in the problem.

In the paper by Mr. Moore the results of small experimental shipments of raw rubber in special baling materials, including paper bags, and the reports on a large consignment shipped in paper bags by a Malayan estate, are described.

The fact that certain large manufacturers who purchase raw rubber in the Singapore market, and other manufacturers owning plantations, ship rubber to their own manufactories in bales is evidence that the baling of rubber in suitable materials is a satisfactory procedure from the manufacturers' standpoint.

The use by the smaller manufacturers of a suitable lubricating powder dusted on the surface of each sheet is indicated. A small premium to cover the extra cost of the powder and labour would be necessary.

Kuala Lumpur
November, 1934

EXPERIMENTS WITH ECONOMIC TAPPING SYSTEMS (1)

BY

C. C. T. SHARP

Introduction

During times of high prices of rubber the object of all tapping systems is to obtain the maximum yield of rubber consistent with the health and longevity of the trees, the cost of tapping being within quite wide limits a matter of only secondary importance. During periods of low prices the reverse is the case; the cost of tapping becomes a large item in estate economy and methods which show promise of reducing this cost, even at the loss of a small proportion of the crop, become popular.

What was probably the first attempt in Malaya in recent times to save tapping costs at a sacrifice of part of the crop was the introduction of A.B.C. tapping by Harrison in 1927 (1). He suggested that if one-third of the estate were rested and the remaining two-thirds tapped alternate-daily the yield would in the course of a few years recover to the normal and the cost of tapping would at the same time be reduced by one-third. His contention has very largely been borne out in practice, but it must be pointed out that there is little or no evidence to show that one-third of the estate is the most suitable proportion to be rested; it might be larger or smaller and is likely to vary with the age and condition of the trees. Nor is there any satisfactory evidence to show what are the most suitable periods of tapping and rest. The most popular arrangement is one year tapping and six months rest, though there is an important body of planting opinion which favours two years tapping and one year of rest. It is hoped that the experiments described in this paper may in time throw some light on the latter question but much experimental evidence is required before any indication can be obtained of the answer to the former question as to the most suitable proportions of tapping to rest.

The next step in the direction of saving in tapping cost was an attempt to use the tappers' time more economically. A tapper's time can be divided into two parts, the time spent in the actual tapping and the time spent in walking from tree to tree. It was argued that if two cuts were put on the tree instead of one the time spent in walking could be halved and the number of trees that

a tapper could deal with could be correspondingly increased without any increase in the total amount of time spent in tapping.

Maas (2) found from observations in Sumatra that on ten-year-old rubber the time spent in walking from tree to tree and the time spent in the actual process of tapping, cleaning the cup etc. were in the proportion of one to four. On fully matured rubber it has been found on Seventh Mile Estate that the proportion is nearer to one to eight. It is probable that the difference in nationality of the tapper is responsible for the greater part of the difference in time of tapping, though clearly a low stand per acre, broken, hilly land and small poorly-grown trees would all tend to increase the proportion of the time spent in walking and enlarge the scope for economy that might be obtained from tapping two cuts instead of one.

The introduction of double-cut tapping systems has progressed along two quite different lines. The first consists of a short intensive period of tapping followed by a period of rest; this is exemplified by the Sunderland system in which the trees are tapped on two cuts every third day. While it lasts this tapping system is one-third as heavy again as ordinary alternate-daily tapping. This is followed by a period of rest equal to the period of tapping or to one-half of the period of tapping according to the nature of the trees and the total intensity of the tapping system considered desirable. Both types of Sunderland system have been tried on a number of estates in Malaya.

The second type of two-cut tapping recently introduced into Malaya is the "double-four" system. This differs from the Sunderland system in that it is much less intensive and can so far as is known at present be continued indefinitely without the introduction of a period of rest. This is not to say that a system of, for example, double-four A.B.C. would not be an improvement, but experimental evidence on this point is necessary. It must also be noted that if double-four tapping with a period of rest is to be adopted the same problems will arise of the most suitable proportion of tapping and rest and the most suitable duration of the resting period which were referred to above in relation to A.B.C. tapping on a single cut.

In the experiment on Seventh Mile Estate an attempt has been made to compare on a large scale and with proper attention to the modern technique of field experiments the merits of some of the tapping systems suited to mature plantations of unselected planting material. Some of the questions discussed above are however outside the scope of this experiment and much more experimental work remains to be done. The introduction of restriction of production with the compulsory resting of a part of every estate offers

opportunities of carrying out experiments on tapping on a large scale of which advantage ought to be taken.

In conclusion it may be stated that the Rubber Research Institute is always ready to co-operate in the designing of field experiments of this nature and to advise as to a suitable method of carrying them out.

Part I

In this paper an account is given of an experiment set up early in 1933 on Seventh Mile Estate, Selangor, designed to test over a period of five years different economic tapping systems against the normal alternate-daily tapping that is customary in Malaya.

Every effort is made within the limits imposed by the necessities of the experiment to conform as nearly as possible to the procedure adopted on the estate on which the experiment is being carried out. Thus each plot consists of a whole tapping task; tapping commences on the experimental area at the same time as on the rest of the estate and the same holidays are taken.

In addition to the records of yield of rubber and scrap, the yield per tapper is also recorded so that the comparative costs of the various tapping systems can be determined.

TAPPING SYSTEMS UNDER TEST

Eight tapping systems are being compared.

They are:—

1. A.B.C. Alternate-daily. Single "V" cut on half the circumference.

Each plot consists of 375 trees sub-divided into three sections A, B, and C, of 125 trees each. During the first three months sections A and B were tapped alternate-daily and section C was rested. During the second three months sections B and C were tapped and section A was rested. During the third period of three months sections A and C were tapped and section B was rested. The areas to be rested will succeed each other in rotation in the above order until the experiment is concluded.

2. This system is the same as number 1 except that the periods of tapping and rest will be for ten and five months instead of six and three months.

3. This is the same as number 1 except that the periods of tapping and rest have been fixed at fourteen and seven months.

4. The "Sunderland" system. Two-cuts third-daily A.B.

The trees are tapped on two half-circumference "V" cuts on opposite sides of the tree on every third day. Each plot consists of 300 trees sub-divided into two sections A and B of 150 trees each. During the first three months section A was tapped and section B was rested. During the second three months section B was tapped and section A was rested.

The sections in tapping and resting will alternate every three months until the conclusion of the experiment.

5. The same tapping system as number 4 but the periods of rest and tapping are five months instead of three months.

6. Also the same as number 4 but the period of tapping and resting are seven months instead of three months.

7. The "Double-four" system. Two-cuts fourth-daily without rest.

The trees are tapped every fourth day on two half-circumference "V" cuts on opposite sides of the tree. Unless compelled by an excessive bark consumption it is not intended to allow any period of rest. Each plot consists of 600 trees sub-divided into four sections A, B, C and D of 150 trees. One section is tapped each day in rotation.

8. Control. Alternate-daily. Each plot consists of 250 trees tapped on alternate days on a single half-circumference "V" cut. No long period of rest is given.

The tapping systems used in this experiment are summarised in Table I.

TABLE I
Summary of Tapping Systems under Test

Plot No.	Tapping Systems	No. of Trees	
		in plot	in task
1	A.B.C. 6 months tapping 3 months rest	375	250
2	" 10 " " 5 " "	375	250
3	" 14 " " 7 " "	375	250
4	Two cuts third-daily 3 months rest & tapping	300	150
5	" " 5 " "	300	150
6	" " 7 " "	300	150
7	Two cuts fourth-daily	600	150
8	Alternate-daily	250	250

Total 2.875

TASK SIZE

On this estate it has been found by experience that with Tamil tappers a task of 250 trees is the most suitable size. This size has been adopted in the single-cut tasks, namely in plots 1, 2, 3, and 8.

Since it is intended as nearly as possible to complete the tapping of the double-cut tasks at the same time as the single-cut tasks, a task size of 150 trees has been chosen for plots 4, 5, 6 and 7.

THE LAY-OUT OF THE EXPERIMENT

A plan of the experiment showing the position of the blocks and plots is shown in Figure 1.

The experimental area contains 17,250 trees divided into six blocks (I to VI in Figure 1) of 2875 trees. Each block is divided into eight plots (1 to 8 in Figure 1). One of the tapping systems described is allotted to each plot. The order in which the plots occur in the blocks was taken at random.

THE EXPERIMENTAL MATERIAL

The area on which the experiment is set up consists of approximately 245 acres planted in 1911 at a planting distance of 18 feet by 14 feet. At the commencement of the experiment the stand was a little less than 70 trees to the acre. The soil is quartzite and the land undulating and broken up by deep ravines the bottoms of which are not planted. The experimental area comprises fields 1, 2 and part of 4; The previous tapping history of each field is shown in Table II.

PREVIOUS YIELDS

The yields in lb. per acre per annum for each field for the three years prior to the commencement of the experiment are given in Table III. The yields in the year 1932 to 1933 are estimated from eleven months' tapping in fields 1 and 2 and nine months' tapping in field 4.



7th MILE ESTATE.
R.R.I. TAPPING EXPERIMENT.

TABLE II

Previous tapping History of the Experimental Area

Field 1 73½ ac. Planted Dec. 1911			Field 2 164 ac. Planted Nov. 1911			Field 4 (Part) 7½ ac. Planted Nov. 1911		
Panel	Height of cut in.	Date of opening Panel: Tapping System	Panel	Height of cut in.	Date of opening Panel: Tapping System	Panel	Height of cut in.	Date of opening Panel: Tapping System
1	18	15.10.15 Daily on 1/3	1	18	15.10.15 Daily on 1/3	1	18	1.1.16 Daily on 1/3
2	21	15.10.16 Daily on 1/3	2	21	15.11.16 Daily on 1/3	2	21	1.2.17 Daily on 1/3
3	24	15.12.17 Daily on 1/3	3	27	15.1.18 Daily on 1/3	3	27	1.4.18 Daily on 1/3
1	36	1.7.19 Daily on 1/3	1	36	1.8.19 Daily on 1/3	1	36	1.10.19 Daily on 1/3
1	18	1.7.20 A. D. on 1/3	1	18	1.8.20 A. D. on 1/3	1	18	1.10.20 A. D. 1/3
2	38	1.2.22 A.D. on 1/3	2	38	1.12.21 A. D. on 1/3	2	36	1.10.22 A. D. on 1/3
		Rested 1.10.27—1.5.28			Rested 1.9.27—1.10.28	A	42	1.5.27 A. D. on ½
A	42	1.5.28 A. D. on ½	A	42	1.10.28 A. D. on ½		40	Rested 1.8.27—31.7.28
								1.8.28 A. D. on ½
								Rested 1.4.33—31.5.33

NOTE:—Panel A consists of panel 3 and half of panel 1.

On 31st May 1933 the cuts in fields 1 and 4 had reached ground level and in field 2 the cut was about 4 inches from ground level.

TABLE III

Previous Yields of the Experimental Area

Pounds per acre per annum

	1930—1931	1931—1932	1932—1933	Mean
Field 1	810	879	907	865
2	767	818	844	810
4	855	896	848	866
Mean yield of whole area				848

METHOD OF RECORDING YIELDS

The latex from each task is brought into the factory and weighed to the nearest half ounce. The contents of the buckets of each tapper are mixed and a sample of about 25 grams is removed with a dipper. This is weighed to the nearest tenth of a gram and coagulated in a glass Petri dish by the addition of 10 c.c. of 5 per cent acetic acid. The coagulum is rolled out into a thin sheet, washed, and dried in the smoke house for twenty four hours and then weighed. The percentage dry rubber content is calculated, and from this and the total weight of latex the total weight of dry rubber from each task in tapping is estimated.

The scrap from each task is weighed separately when brought in. It has been found that the wet scrap from the single-cut tasks contains about 20 per cent of water and from the double-cut tasks about 30 per cent of water. The dry weight of the scrap is estimated on the basis of these figures.

The amount of lump is small and is not taken into consideration.

TAPPERS

The tappers employed in this experiment are Tamil men. Four tappers are assigned to each block. To eliminate as far as possible variations in skill between the different tappers, those known to be very much above or below the average in skill were not employed in the experiment and the tasks allotted to the tappers chosen were changed after every twenty four tapping days in the manner described below.

*Plots tapped in each successive Period of 24
tapping Days by each Tapper*

Tapper	1st period	2nd period	3rd period	4th period	5th period
No. 1	1, 2	7	4, 5, 6	3, 8	1, 2
No. 2	3, 8	1, 2	7	4, 5, 6	3, 8
No. 3	4, 5, 6	3, 8	1, 2	7	4, 5, 6
No. 4	7	4, 5, 6	3, 8	1, 2	7

Since each tapper in each group of four will tap in rotation one plot of all tapping systems it is considered unnecessary to change them from one block to another.

HEIGHT OF CUT AND BARK CONSUMPTION

In fixing the opening height of the tapping cut there were two possibilities. It would have been possible either to have varied the height of the tapping cut so that the period allowed for bark renewal would have been the same in each tapping system or to have fixed the height of the cut at the same level in each plot and to have varied the period allowed for renewal. The former system was chosen and the period allowed for renewal has been fixed at ten years.

The experiment has been timed to last for five years by which time a complete panel on half the circumference should be tapped out. In practice it has been found impossible to open the cuts at the required height. To have done so would have necessitated the tapping of renewed bark of less than six years of age. To avoid this all the cuts were raised by six inches so that by the end of five years the cuts on the single-cut system and the lower cuts on the double-cut systems should all reach a point six inches above ground level.

On the single-cut systems a bark consumption of $\frac{3}{4}$ inch per month tapped has been allowed.

On the three Sunderland-system plots a bark consumption of 4 inches per annum on each panel has been estimated. This allows for a shaving of 0.067 inch per tapping to be removed as against 0.05 inch on the single cut. The increased allowance of bark has been permitted to compensate for the greater drying out that is experienced with third-daily tapping compared with the alternate-daily.

In the double-four system $4\frac{1}{2}$ inches per panel or 9 inches per year has been allowed. A further increase in bark consumption to compensate for the long interval between tapping would not be practicable since it would have necessitated either shortening the period of renewal or raising the upper cut to an excessive height.

In addition to the allowances for bark consumed in tapping, an extra $\frac{1}{2}$ inch was added for opening the cuts on virgin bark and $\frac{1}{4}$ inch on renewed bark, an extra $\frac{1}{4}$ inch for re-opening a cut after a period of rest and $2\frac{1}{2}$ inches for the cup.

Details of the initial heights of the tapping cuts are given in Table IV.

TABLE IV

*Programme of Bark Consumption and initial
Heights of Tapping Cuts*

Tapping System	Bark Consumption		Allowance for :-			Initial height of Tapping Cut inches
	per year inches	per five years inches	Opening inches	Reopening old panel inches	Cup inches	
1. A.B.C. 3 months	6	30	$\frac{1}{4}$	$1\frac{1}{2}$	$2\frac{1}{2}$	$34\frac{1}{4}$
2. A.B.C. 5 months	6	30	$\frac{1}{4}$	1	$2\frac{1}{2}$	$33\frac{3}{4}$
3. A.B.C. 7 months	6	30	$\frac{1}{4}$	1	$2\frac{1}{2}$	$33\frac{1}{2}$
4. 2 cuts third-daily } 3 months	upper 4 8 lower 4	20 40 20	$\frac{1}{2}$ $\frac{1}{4}$	$2\frac{3}{4}$ $2\frac{3}{4}$	$2\frac{1}{2}$ $2\frac{1}{2}$	$45\frac{3}{4}$ $25\frac{1}{2}$
5. 2 cuts third-daily } 5 months	upper 4 8 lower 4	20 40 20	$\frac{1}{2}$ $\frac{1}{4}$	$1\frac{1}{4}$ $1\frac{1}{4}$	$2\frac{1}{2}$ $2\frac{1}{2}$	$44\frac{3}{4}$ $24\frac{1}{2}$
6. 2 cuts third-daily } 7 months	upper 4 8 lower 4	20 40 20	$\frac{1}{2}$ $\frac{1}{4}$	1 1	$2\frac{1}{2}$ $2\frac{1}{2}$	44 $23\frac{3}{4}$
7. Double-four } upper	$4\frac{1}{2}$ 9 $4\frac{1}{2}$	$22\frac{1}{2}$ 45 $22\frac{1}{2}$	$\frac{1}{2}$ $\frac{1}{4}$	— —	$2\frac{1}{2}$ $2\frac{1}{2}$	48 $25\frac{1}{4}$
8. Alternate-daily	9	45	$\frac{1}{2}$	—	$2\frac{1}{2}$	48

Note :—To avoid tapping renewed bark of less than six years of age all the cuts were opened at six inches above the heights shown in the right hand column of the above table.

Part II

Results of tapping for the first year

June 1933—May 1934

The total yields of dry rubber not including scrap, for the first year of the experiment are shown in Table V.

TABLE V

Yields June 1933—May 1934

Total Yield per Plot (lb. dry Rubber) excluding Scrap

Block	Plots and Tapping Systems							
	1	2	3	4	5	6	7	8
	A. B. C.	A. B. C.	A. B. C.	Sunder- land	Sunder- land	Sunder- land	Double- four	Alter- nate- daily
	6-3	10-5	14-7	3-3	5-5	7-7		
I	2,524.5	2,669.6	2,240.2	1,690.3	2,037.1	1,821.0	6,095.1	2,245.4
II	2,443.0	2,066.8	2,187.2	1,509.4	1,556.8	1,546.6	5,557.8	2,041.1
III	2,373.1	2,340.5	2,389.0	1,184.4	1,850.1	1,267.4	4,698.5	2,016.7
IV	2,684.5	3,149.6	2,737.9	1,671.5	1,837.1	1,602.9	6,290.0	2,718.8
V	2,857.4	2,522.7	2,664.2	2,016.0	1,587.9	1,633.9	6,400.0	1,978.1
VI	2,262.9	2,003.6	1,808.9	1,432.2	1,511.7	1,472.7	5,028.6	2,399.8
	15,145.4	14,752.8	14,027.4	9,503.8	10,380.7	9,344.5	34,070.0	13,399.9

Grand Total = 120,624.5 lb.

In Table VI the figures from Table V have been recalculated to yield per acre (70 trees) and the figures for scrap and total weight of dry rubber have been included.

In Table VII the mean yield per acre of first-grade rubber is shewn for each month of the experiment in pounds of dry rubber and as a percentage of the control. In addition, the total yield up to the end of each month is given as a percentage of the control. This last figure is also shown as a graph in Figure 2.

TABLE VI
Yield in lb. per Acre for first Year of tapping of first-grade Rubber, scrap Rubber and total dry Rubber

		Plots and Tapping Systems.							
Block		¹ A. B. C. 6-3	² A. B. C. 10-5	³ A. B. C. 14-7	⁴ Sunderland 3-3	⁵ Sunderland 5-5	⁶ Sunderland 7-7	⁷ Double-four	⁸ Alternate-Daily
		I 471.2	498.3	418.2	394.4	475.3	424.9	711.1	628.7
First-Grade Rubber	II	456.0	385.8	408.3	352.2	363.3	360.9	648.4	571.5
	III	443.0	436.9	446.0	276.4	431.7	295.7	548.2	564.7
	IV	501.1	587.9	511.1	390.0	428.7	374.0	733.8	761.3
	V	533.4	470.9	497.3	470.4	370.5	381.2	746.7	553.9
	VI	422.4	374.0	337.7	334.2	352.7	343.6	586.7	671.9
	Mean	471.2	459.0	436.4	369.6	403.7	363.4	662.5	625.3
Scrap.	Per cent.	75.4	73.4	69.8	59.1	64.6	58.1	105.9	100.0
	Mean	56.2	55.9	52.9	59.9	64.2	64.5	137.6	82.6
	Per cent. of First-grade	11.9	12.2	12.1	16.2	15.9	17.1	20.8	13.2
	Mean	527.4	514.9	489.3	429.5	467.9	427.9	800.1	707.9
Total Dry Rubber	Per cent.	74.5	72.7	69.1	60.7	66.1	60.4	113.0	100.0

General mean = 473.9 lb. first-grade rubber per acre.

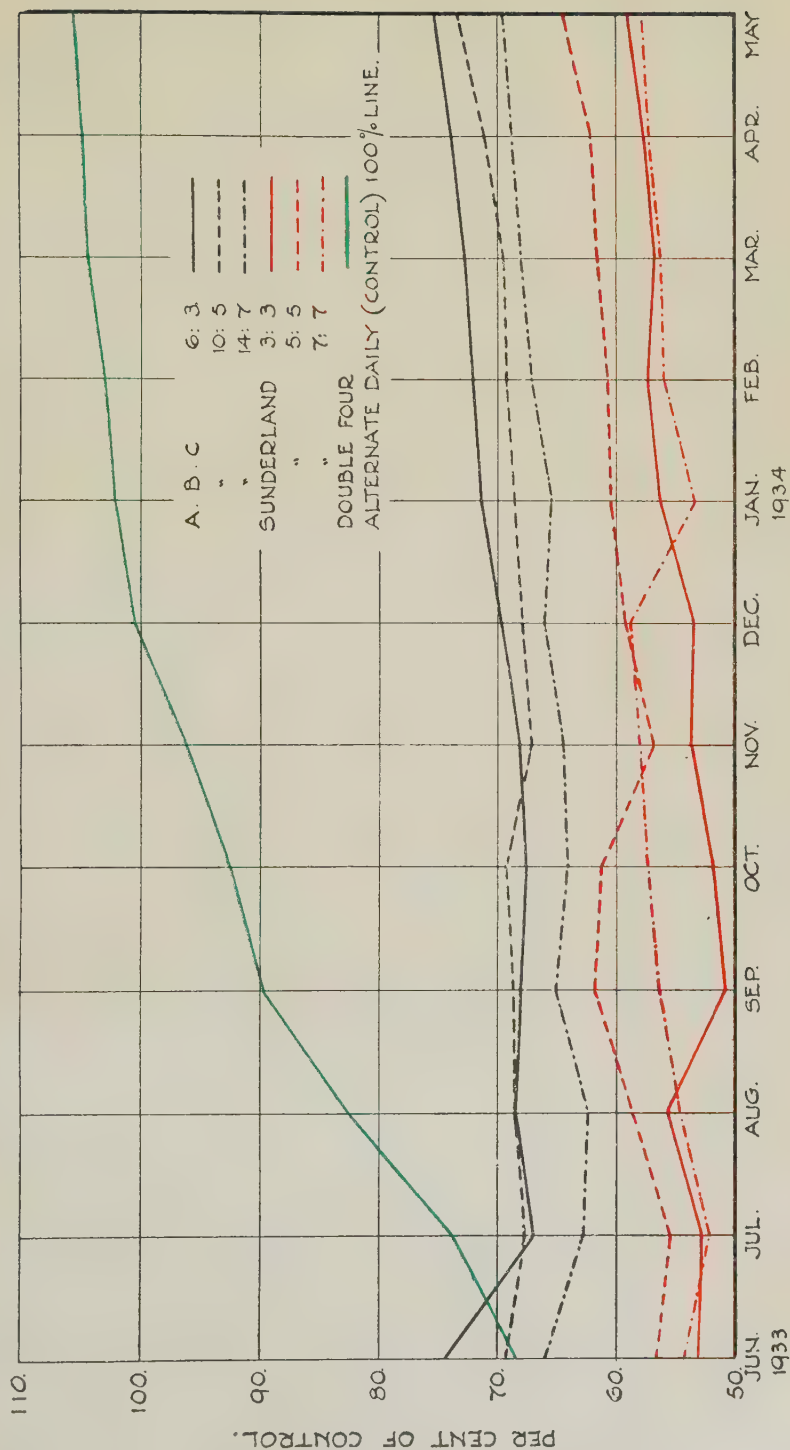
TABLE VII

Mean Yield in Pounds per Acre per Month of first-grade Rubber

Plots and Tapping Systems																									
Month		1 A.B.C. 6-3			2 A.B.C. 10-5			3 A.B.C. 14-7			4 Sunderland 3-3			5 Sunderland 5-5			6 Sunderland 7-7			7 Double-four			8 Alternate-Daily		
		Yield			Yield			Yield			Yield			Yield			Yield			Yield			Yield		
		lb.	per cent	Total per cent	lb.	per cent	Total per cent	lb.	per cent	Total per cent	lb.	per cent	Total per cent	lb.	per cent	Total per cent	lb.	per cent	Total per cent	lb.	per cent	Total per cent	lb.	per cent	Total per cent
June	1933	30.5	74.7	74.7	28.4	69.6	69.6	26.9	66.0	66.0	21.6	53.0	53.0	23.2	56.8	56.8	22.2	54.3	54.3	28.0	68.5	68.5	40.8	100	100
July	...	31.9	61.3	67.2	34.8	66.9	67.9	31.4	60.4	62.9	27.1	52.1	52.5	28.0	53.9	55.1	26.2	50.4	52.1	40.7	78.3	74.0	52.0	100	100
August	...	41.8	71.4	68.8	41.1	70.2	68.8	36.0	61.5	62.3	35.3	60.3	55.5	37.8	64.6	58.8	34.4	58.8	54.7	56.3	96.3	82.6	58.5	100	100
September	...	35.5	66.6	68.3	36.9	69.2	68.9	39.0	73.2	65.2	19.3	36.2	50.5	37.1	69.6	61.6	32.6	61.2	56.4	59.1	110.9	90.0	53.3	100	100
October	...	39.2	65.9	67.7	42.1	70.8	69.3	36.0	60.5	64.1	33.0	55.5	51.7	35.3	59.3	61.1	36.3	61.0	57.4	61.0	102.5	92.8	59.5	100	100
November	...	40.7	71.5	68.4	33.4	58.6	67.4	38.1	66.8	64.5	35.2	61.7	53.4	21.4	37.5	56.9	34.7	60.9	58.0	64.5	113.2	96.4	57.0	100	100
December	...	41.8	78.4	69.8	38.8	72.8	68.1	40.1	75.2	66.1	27.3	51.2	53.1	38.9	73.0	59.2	34.3	64.4	58.9	67.6	126.9	100.7	53.3	100	100
January	1934	40.5	81.8	71.2	36.8	74.3	68.9	30.8	62.2	65.6	39.2	79.2	56.1	34.3	69.3	60.4	14.1	28.5	53.4	56.1	113.3	102.2	49.5	100	100
February	...	42.3	78.9	72.1	39.1	72.9	69.3	42.4	79.1	67.1	36.0	67.2	57.4	33.6	62.7	60.6	32.2	60.1	56.0	60.6	113.1	103.4	53.6	100	100
March	...	36.5	79.7	72.7	33.3	72.7	69.6	36.7	80.1	68.3	24.2	52.8	57.0	32.7	71.5	61.6	27.5	60.0	56.3	53.9	117.7	104.6	45.8	100	100
April	...	43.8	87.4	74.0	43.2	86.2	71.0	38.0	75.9	68.9	34.0	67.8	57.9	34.6	69.1	62.2	34.6	69.1	57.4	54.7	109.1	105.0	50.1	100	100
May	...	46.7	90.0	75.4	51.0	98.3	73.4	41.0	79.0	69.8	37.4	72.1	59.1	46.8	90.2	64.6	34.3	66.1	58.1	60.0	115.6	105.9	51.9	100	100

NOTE:—The thick horizontal lines indicate the point at which a rested section is brought into tapping and a tapped section taken into rest.

Fig. 2. TOTAL YIELD AS PERCENTAGE OF CONTROL.



That the differences in yield are caused chiefly by differences in tapping system is shown by the Analysis of Variance in Table VIII.

TABLE VIII

Analysis of Variance. First-grade Rubber

	Degrees of Freedom	Sums of Squares	Mean Squares
Tapping Systems ...	7	528865.2	75552.2
Blocks	5	84077.6	16815.5
Error	35	79332.4	2266.6

The mean square due to tapping systems is very much greater than that due to error and the experiment is therefore fully significant.

The standard error of the mean of six plots is equal to 19.4 lb. or 4.1 per cent of the general mean of 473.9 lb. per acre. Taking

TABLE IX

Yield per Tapper and Comparative Cost of Tapping

Tapping System	YIELD PER TAPPER PER TAPPING			COMPARATIVE COST PER LB.		COMPARATIVE YIELD PER ACRE	
	First grade rubber lb.	crap rubber lb.	Total dry rubber lb.	First grade rubber per cent	Total dry rubber per cent	First grade rubber per cent	Total dry rubber per cent
1	14.7	1.7	16.4	87.8	88.8	75.4	74.5
2	14.2	1.7	15.9	90.8	91.6	73.4	72.7
3	13.6	1.6	15.2	94.9	95.9	69.8	69.1
4	14.0	2.3	16.3	92.1	90.4	59.1	60.7
5	15.0	2.4	17.4	86.0	84.5	64.6	66.1
6	13.5	2.4	15.9	95.6	92.8	58.1	60.4
7	16.5	3.4	19.9	78.2	74.7	105.9	113.0
8	12.9	1.7	14.6	100.0	100.0	100.0	100.0

twice the standard error of the difference between two means as a test of significance, differences in the yields of the tapping systems under test of less than 11.6 per cent or 55 lb. must be regarded as being possibly due to chance and not to the tapping system employed.

YIELD PER TAPPER AND COST OF TAPPING

The yield per tapper per tapping and the cost of tapping are shown in Table IX.

Since it would be misleading if no notice were taken, in calculating the cost per lb. of tapping, of the difference in value between first-grade rubber and scrap, the total weight of dry rubber is assumed to be the weight of first-grade rubber plus three-quarters of the weight of the scrap, and the comparative cost of harvesting the total dry rubber is calculated from this figure.

TABLE X
Mean Dry Rubber Content

Month		Tapping Systems							
		1	2	3	4	5	6	7	8
June	1933	43.5	43.7	43.2	43.9	42.6	43.7	44.1	44.0
July	...	41.8	42.3	42.3	43.6	42.6	43.2	45.5	43.7
August	...	<u>41.8</u>	40.5	40.8	<u>41.4</u>	41.9	42.3	43.1	41.7
September	...	42.7	40.2	39.7	47.4	40.3	41.1	42.1	41.4
October	...	40.4	<u>39.4</u>	38.9	43.9	<u>39.9</u>	39.6	42.1	41.0
November	...	<u>40.3</u>	42.1	39.7	<u>42.3</u>	48.7	40.4	41.2	41.4
December	...	42.8	40.8	<u>39.9</u>	46.0	43.2	<u>37.7</u>	40.4	40.8
January	1934	41.5	40.8	41.8	42.3	41.9	46.0	41.3	40.8
February	...	<u>40.9</u>	40.8	40.7	<u>41.9</u>	41.8	45.4	41.8	42.1
March	...	40.3	<u>40.0</u>	39.7	42.1	<u>40.1</u>	41.0	39.7	41.0
April	...	39.5	41.5	38.0	39.6	45.2	39.7	38.5	38.9
May	...	38.4	38.8	37.3	39.1	39.5	38.9	39.3	39.5

The horizontal lines show the points at which tapped and rested sections were changed over

For convenience of reference the figures from Table VI for the comparative yields of first-grade rubber and total dry rubber are included in Table IX.

The mean dry rubber content in each month is shown in Table X.

Discussion

A.B.C. TAPPING; PLOTS 1, 2 AND 3

The largest difference in yield, amounting to 34.8 lb. of first-grade rubber, is between plots 1 and 3. This difference is only slightly larger than the standard error and cannot be regarded as statistically significant. It may be concluded from this that if there is any difference in yield as a result of varying the period of tapping and rest it has not shown itself with certainty by the end of the first year. The loss in crop compared with the control amounts to 19 per cent for the whole year, but that the benefit of the rest is having a satisfactory effect is shown by the fact that the mean loss in yield in the twelfth month amounts to only 11 per cent (Table VII).

SUNDERLAND SYSTEM; PLOTS 4, 5 AND 6

Although there are the same number of half-circumference cuts per annum in the A.B.C. plots and in the Sunderland plots, the yield of the latter is consistently lower than that of the former and there is no corresponding saving in tapping costs; at the end of the first year the Sunderland system has shown itself to be definitely inferior to A.B.C. tapping on this type of rubber.

DOUBLE-FOUR SYSTEM; PLOT 7

At the end of the first year double-four plots have shown an increase in yield of 5.9 per cent and a saving in tapping costs of 21.8 per cent, or 13 per cent and 25.3 per cent if scrap is included in the total yield. On the other hand it must be pointed out that the double-four has had an advantage over the control in that the mean height of the two cuts was lower than the height of the single cut of the control plots. By the time the experiment is concluded this advantage will have been eliminated but from the data provided in Table IV it can be calculated that the mean heights of the two cuts of the double-four plots and the single-cuts of the control plots were 40 and 49 inches respectively during the first year. From Grantham's (3) data as published by Ashplant it can be determined that the yields at 40 and 49 inches would be in the proportion of 109 to 100. The actual yield of the double-four

plots has been found to be equal to 105.9 per cent, or 113 per cent if scrap is included, of the yield of the control, a very close agreement with the theoretical figure.

Summary

A description of the tapping experiment on mature rubber on Seventh Mile Estate designed to compare eight different tapping systems and the results of the first year of tapping are presented.

This experiment is to last for at least five years and in summarising below the inferences to be drawn from the first year's results the possibility that they will have to be modified later must not be disregarded.

- (i) The A.B.C. tapping systems show a loss of 28 per cent of crop and a saving of 8 per cent in tapping costs
- (ii) The Sunderland system shows a loss of 38 per cent and a saving in tapping costs of 11 per cent
- (iii) The double-four system shows no loss in crop but a saving in tapping costs of 25 per cent

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2. MAAS J. G. J. A. ... *Archief v.d. Rubber Cultuur* **9**.
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3. ASHPLANT H. ... *Recent Developments in the Rubber Planting Industry. Rubber Growers' Association, London.*

Kuala Lumpur

1st October 1934

NOTES ON A TAPPER'S WORKING TIME

BY

C. C. T. SHARP

The time that a tapper spends in tapping his task, excluding the time spent in collection, can be divided into two parts; that spent in the actual work of tapping including the collection of tree-scrap and cup-scrap, cleaning the cup and setting it in position, and that spent in walking from tree to tree. The time spent in walking is from the point of view of the owner of the rubber entirely unproductive and the recent experiments with double-cut tapping systems have been made in an attempt to reduce the time so spent and in consequence to use the tapper's time more economically.

Maas* examined the question in Sumatra and came to the following conclusions:—

- (a) The average time spent in tapping and walking was 19.6 and 5.2 seconds respectively
- (b) The average time spent in collection and walking was 9.6 and 5.2 seconds respectively
- (c) Of the actual time spent in tapping most is spent in starting and finishing the cut, collecting the scrap rubber etc., in consequence of which the length of cut makes relatively little difference to the total time required for tapping.

The analysis of a tapper's time described in these notes has been made in order to see to what extent Maas's conclusions are applicable to Malayan conditions and to examine the actual basis of the economies expected from double-cut tapping.

The observations from which this analysis is made were taken in the Rubber Research Institute Experimental Block on Seventh Mile Estate. A description of this experiment appears in this *Journal* and will not be repeated here. It will be sufficient for this purpose to record that the land was undulating with a stand of 70 trees to the acre.

In selecting the 24 tappers to be employed in the experimental area, women and tappers known to be much above or below the average in skill were rejected. From the 24 tappers thus selected,

*MAAS, J. G. J. A. *Archief voor de Rubbercultuur* 9 (1925) 179

TABLE I
Time spent in Tapping and Walking

Task	A. D.		A. B. C.		Sunderland			Double-Four			Mean	
	Tapping Sec.	Walking Sec.	Tapping Sec.	Walking Sec.	Tapping Upper Sec.	Lower Sec.	Walking Sec.	Tapping Upper Sec.	Lower Sec.	Walking Sec.		
Mean Girth	45.6 in.		46.4 in.		44.5 in. 50.8 in.			44.0 in. 50.2 in.				
Mean Height of Out	44.5 in.		31 in.		42.5 in. 22 in.			46 in. 23.5 in.				
Tapper A	41.2	5.0	33.8	6.3	34.9	36.8	6.4	34.0	36.0	6.0	36.1	5.9
B	37.4	5.2	37.6	5.8	31.3	34.7	5.7	41.3	43.7	6.1	37.7	5.7
C	55.1	6.2	45.8	5.5	50.2	49.0	5.9	47.7	50.0	5.9	49.7	5.9
D	44.3	4.0	31.8	4.7	40.2	39.6	5.6	32.7	34.8	5.2	37.3	4.9
E	38.0	4.5	34.6	4.7	38.0	42.4	4.9	42.8	45.0	5.6	40.1	4.9
F	44.5	5.3	44.0	5.0	39.9	47.6	4.7	38.9	46.7	5.2	43.6	5.0
G	31.5	5.6	28.0	5.1	28.0	33.1	5.2	30.2	33.6	4.8	30.7	4.2
H	53.8	5.8	50.9	5.1	39.3	47.9	5.2	35.7	41.7	5.8	44.9	5.5
Mean	43.2	5.2	38.3	5.3	37.7	41.8	5.5	37.9	41.4	5.6	40.0	5.3

eight who were considered to be representative of the average were chosen for the purpose of this analysis.

The tapper's time was divided into two parts, tapping time and walking time as described above. A more detailed analysis of the tapping time was not considered practicable. Each tapper was timed with a stop-watch while he tapped 50 trees in a double-four task, a Sunderland task, an A.B.C. task and an alternate-daily task. This was rendered possible by the fact that the task allotted to each tapper was changed in rotation every 24 days. In the Sunderland and double-four tasks the time spent in tapping the upper and lower cuts was recorded separately.

In addition the time spent in collection was recorded for fifty trees in one double-cut task and one single-cut task.

The girth of every tree was measured at the height of the top of the two corners of the "V" cut.

Girth measurements were made to the nearest half-inch and times were taken to the nearest fifth of a second.

The time spent in tapping and walking is set out in Table I.

The coefficient of correlation between the time spent in tapping and the girth of each tree was calculated. The results are set out below in Table II.

TABLE II

Positive Correlations—Time of Tapping and Girth of Trees

Tapper	Tapping Systems						Mean
	A.D.	A.B.C.	Sunderland		Double-four		
			Upper cut	Lower cut	Upper cut	Lower cut	
A	.7568	.6527	.5785	.6683	.7136	.6443	.6690
B	.6789	.6518	.6442	.6238	.6594	.6664	.6541
C	.6655	.8260	.7772	.7326	.7649	.6024	.7281
D	.5198	.7326	.5967	.5820	.6691	.6606	.6268
E	.5940	.8888	.6676	.6230	.7173	.6158	.6844
F	.6735	.7153	.6811	.6153	.7652	.6606	.6852
G	.6845	.7106	.6890	.6039	.6606	.5193	.6440
H	.6463	.8104	.6775	.6360	.6670	.5269	.6607
Mean	.6524	.7485	.6640	.6356	.7021	.6120	.6691

It is clear from the above table that there is a well-defined relationship between the size of the tree and the time spent in tapping, differing in this respect from the results obtained by Maas under Sumátran conditions.

Ignoring the size of the trees the average time required for tapping is 40 seconds and for walking $5\frac{1}{4}$ seconds, being in the proportion of 88.5 : 11.5.

Even after the selection of the tappers already described there is considerable variation in the speed at which they work, the fastest worker completing his task in approximately three-fifths of the time of the slowest.

It has already been shown that there is a close relationship between the girth of the trees and the time spent in tapping. To measure the extent of this relationship, the girths of the trees have been arranged in groups at intervals of two inches and the mean time of tapping for each group has been calculated. The results are shown in Table III and illustrated in Figure 1. Trees with a girth of over 70 inches or less than 30 inches were few in number and have been omitted from the Table.

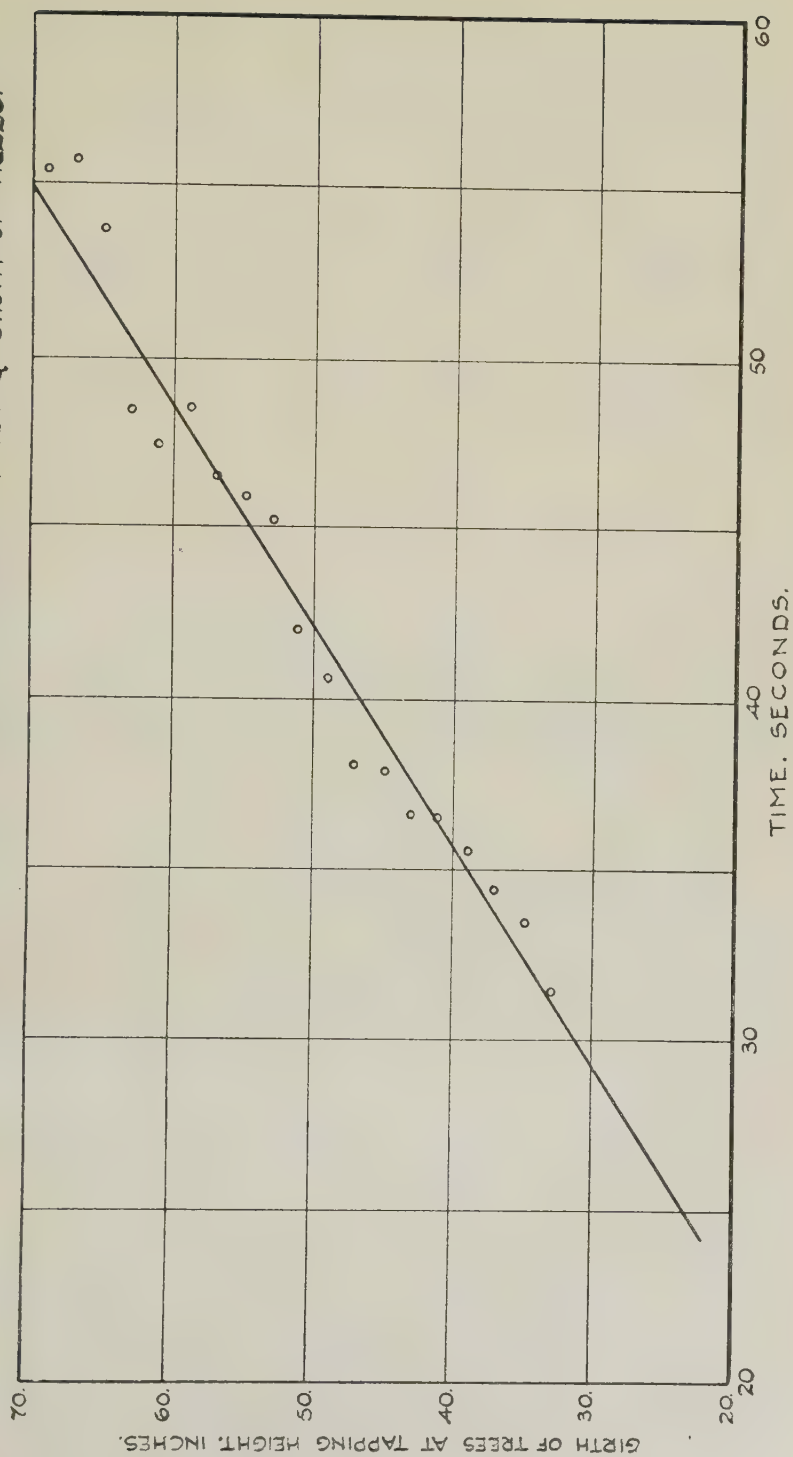
TABLE III

Mean Time of tapping a half-circumference Cut on Trees with different Girths

Girth in.	No. of trees	Mean time of tapping sec.	Girth in.	No. of trees	Mean time of tapping sec.
30—	47	29.4	50—	129	41.9
32—	93	31.3	52—	122	45.2
34—	121	33.3	54—	126	45.9
36—	153	34.3	56—	109	46.5
38—	177	35.5	58—	79	48.6
40—	189	36.5	60—	60	47.5
42—	189	36.6	62—	45	48.5
44—	191	37.9	64—	38	53.7
46—	217	38.1	66—	25	55.7
48—	188	40.6	68—	17	55.3

For practical purposes the time required for tapping a half-circumference "V" cut with Tamil tappers, exclusive of walking, can be estimated by allowing nine seconds for each tree and adding

FIG. 1. TIME OF TAPPING A SINGLE HALF CIRCUMFERENCE V CUT & GIRTH OF TREES.



two-thirds of a second for each inch of circumference of the tree at the tapping height.

Assuming a constant walking time of $5\frac{1}{4}$ seconds the proportion of tapping time to walking time for trees of varying mean girths would be as follows:

Girth of tree in.	Tapping time sec.	Proportion of tapping time to walking time
30	$28\frac{1}{2}$	5.4 : 1
35	32	6.1 : 1
40	35	6.7 : 1
45	$38\frac{1}{2}$	7.3 : 1
50	$41\frac{1}{2}$	7.9 : 1

COLLECTION

Under Malayan conditions the time spent in collection is, within quite wide limits, a matter of no great importance. The times recorded for a single-cut task and a double-cut task are shown in Table IV.

TABLE IV
Time spent in Collection and Walking

Tapper	Single-Cut		Double-Cut	
	Collection sec.	Walking sec.	Collection sec.	Walking sec.
A	5.0	5.2	9.7	4.8
B	4.4	4.9	10.8	5.0
C	4.0	4.2	12.5	5.2
D	4.7	4.9	11.5	4.3
E	5.6	4.4	9.8	4.7
F	5.5	4.0	12.5	5.3
G	4.1	3.6	8.4	4.5
H	9.3	5.6	14.8	6.3
Mean	5.3	4.6	11.3	5.0

Taking the collection and walking together the average times required for collection in single and double-cut tasks are 10 seconds and 16.3 seconds, an increase of 63 per cent. On the other hand the mean time for tapping a single-cut task is 46.0 seconds and for a double-cut task 85 seconds, an increase of 85 per cent.

The increase in time required for collection in the double-cut tasks is therefore proportionately less than for tapping in this particular case when the trees had a mean girth at the tapping height of $47\frac{1}{2}$ inches.

If the double-cut tasks are fixed at such a size that they would normally be completed by the same time as single-cut tasks the total time spent in collection would be less in the case of double-cut tasks than in single-cut tasks.

Discussion

It has been shown that the time spent in tapping bears a much closer relationship to the size of the trees than would be expected from Maas's observations in Sumatra. It follows from this that, regarded solely from the point of view of the time spent in tapping, the greatest economy in tapping with double-cut systems will be obtained in tapping small poorly-grown trees. It is also self-evident that a low stand per acre, very hilly land and selective tapping will increase the total proportion of walking time and provide those conditions in which the maximum economy can be obtained from double-cut tapping systems. It may therefore be concluded that double-cut tapping systems will show the greatest economy in tapping time when applied to poor-yielding areas which are usually associated with one or more of the four conditions stated above.

Kuala Lumpur,

2nd October, 1934

OIDIUM HEVEAE

REPORT ON THE 1934 OUTBREAK OF HEVEA LEAF MILDEW

BY

F. BEELEY

Early last year it was announced by several leading meteorologists that a consequence of the commencement of a new phase in sun-spot activity would be a considerable change in the normal meteorological conditions on the earth and that the weather conditions would probably be abnormal during late 1933 and in 1934. Generally, the effect of this new phase of sun-spot activity has been to cause continuous droughts in temperate regions and steady, continuous rain in tropical regions.

In Malaya during January, when the leaves of rubber trees should normally commence to change colour, abnormally heavy rains were experienced as a result of which wintering was not only delayed but, in many districts, a comparatively high percentage of trees did not look like wintering for some months.

The weather brightened considerably in February and some of the rubber on the steeper foothills at once began to winter and by early March had obtained a crown of good healthy foliage. In the first few days of March, however, the weather became dull with heavy mists, low cloud and frequent rain during the middle of the day. Under these conditions wintering, after having made a late start, was again delayed so that not only was wintering irregular and patchy in different districts but individual fields contained trees in various stages of wintering and refoliation, and many instances were observed where trees over 20 years old had put on new growth and new terminal whorls of leaves before shedding the old leaf.

This unseasonable weather continued throughout March and April except for a fine spell with only occasional showers between March 24 and April 5.

At the end of 1933 a circular was sent to all estate managers reminding them of the need to report this disease and, combined with lectures and demonstrations in the various districts, has resulted in a record number of reports, nearly three times as large as last year's, being sent in. Over a period of eleven weeks, from March 1st to May 21st, no fewer than 180 reports of abnormal leaf-fall were received.

TABLE I

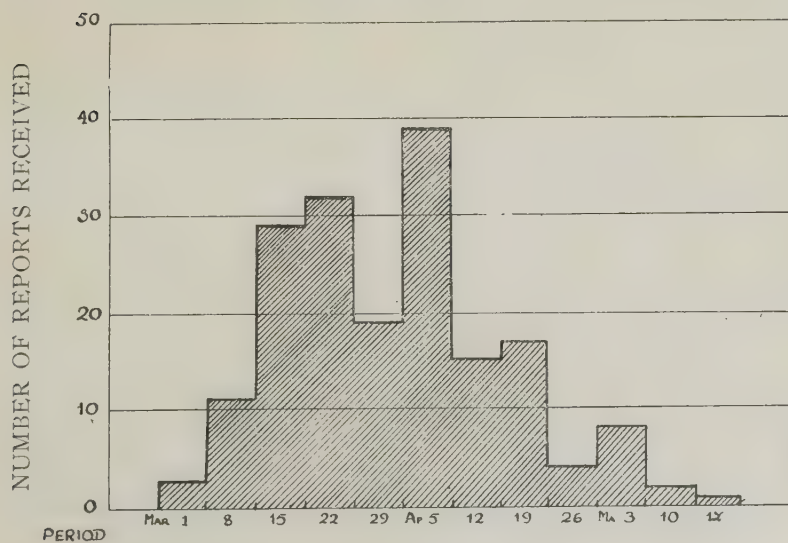
Reports received per Week from each State; 1934

	March					April				May			
	1	8	15	22	29	5	12	19	26	3	10	17	Total
Johore	1	4	0	1	2	3	2	1	0	2	0	0	16
Malacca	0	0	1	4	3	6	0	1	0	1	0	0	16
Negri Sembilan	2	6	10	11	4	11	6	3	1	0	0	0	54
Selangor	0	0	4	8	4	11	5	7	1	0	0	1	41
Perak	0	0	3	3	2	5	2	3	0	1	0	0	19
Province Wellesley	0	1	5	0	1	0	0	0	0	0	0	0	7
Kedah	0	0	6	5	3	3	0	1	0	0	0	0	18
Pahang	0	0	0	0	0	0	0	1	2	4	2	0	9
Total	3	11	29	32	19	39	15	17	4	8	2	1	180

OIDIUM HEVEAE

1934

NUMBER OF REPORTS RECEIVED PER WEEK PERIOD



The three earliest reports were received towards the end of the first week of March from Johore and Negri Sembilan. The following week four reports from Johore, six from Negri Sembilan and one from Province Wellesley were received. It was not until the third week of March that reports were received from every State west of the main range. Reference to Table I and the graph will indicate the time of first-noticed leaf-fall in the various States and the number of reports received in weekly periods during the season.

It may be that the reduction in the number of reports during the week March 29th—April 4th was due to the brighter weather experienced during that time.

Very few cases of serious leaf-fall were reported and these concerned only small areas on poor soil. The majority of reports described the outbreak as a very mild one. Even in Negri Sembilan and Malacca, though a heavy infection was present, comparatively little leaf-fall took place, while the foliage generally is considerably better than in recent years. Other districts, however, have reported leaf-fall where, in previous years, no leaf-fall had been noticed; for example Kedah, which usually enjoys a very severe wintering has had, owing to the rain, a very prolonged, indefinite wintering season with consequent growth and development of the mildew fungus, so that in some fields of the older-planted districts the foliage is rather poor. Similarly West Pahang suffered a very late prolonged wintering in dull weather and a considerable fall of leaf took place on the poorer areas. Selangor and Perak had a similar mild attack which again could be attributed to the dull showery weather retarding the development of the young leaf.

Early in May, inspection tours were made through the various districts. The following is a brief description, from observation and information supplied by estate managers, of the situation in regard to foliage at the end of the wintering and refoliation season.

JOHORE

The rubber areas of Johore had experienced a mild attack of leaf-mildew rather late in the season. The disease caused a mild fall of leaf from the lower and central branches evident chiefly in the extreme north and extreme south of the State. The crown foliage appeared to be in good condition. Wintering appeared to have been late and patchy.

MALACCA

Compared with last year the present attack of mildew has proved comparatively mild. Wintering has been rather late and very patchy, the earlier foliage completely escaping attack, later trees being attacked usually in the lower branches, though occasional trees were observed which had lost nearly all their new foliage. In northern Malacca a number of areas of poor rubber were observed which had obviously suffered a severe attack causing considerable general leaf-fall. Central and inland districts had completely recovered from a mild attack and the trees carry a good crown of foliage.

NEGRI SEMBILAN

Districts east of Seremban appeared to have little noticeable fall of leaf, though the fungus could be demonstrated in practically every large area of rubber. The coastal districts, west of Seremban, were again the chief areas in which numerous outbreaks were reported.

In these districts several detailed observations revealed an average state of foliage in May as follows:—

(a) Trees not wintering still carrying old green leaf		3 per cent
(b) Trees not wintering but producing new stem growth and leaf		3 " "
(c) Trees wintering in upper branches only		10 " "
(d) Trees with mature new leaves at the top and young diseased leaves below		24 " "
(e) Trees with new leaves at the top and old below		7 " "
(f) Trees with an excellent crown of new foliage	25	" "
(g) Trees estimated to have lost over 50 per cent of leaves through mildew defoliation	25	" "
(h) Trees showing a second growth of new leaves		3 " "

Generally, the wintering throughout the districts has been patchy and slow, followed by irregular refoliation. In spite of this, however, extent of infection and leaf-fall have been considerably less than last year, while the new foliage and terminal shoot growth is very good.

SELANGOR

Practically every rubber-growing district of Selangor has suffered from leaf mildew in a greater or less degree. Actual leaf-

fall has, however, been small and confined chiefly to the lower shaded branches. Wintering was very late and protracted owing to the unseasonable weather. Terminal shoot growth and general leaf development has been slow but good and stag-head branches can rarely be seen. In a few rare instances trees may be observed which have lost the greater part of their central and lower foliage while the crowns bear an excellent foliage. *Oidium* was observed to be causing a serious leaf-fall in some small swampy areas and poor hill-land rubber in the Tanjong Malim district.

The younger rubber throughout the State has been free from leaf-fall, although the presence of the fungus on the leaf has been repeatedly demonstrated. Although the high number of reports (41) may indicate the seriousness of the situation, it is pleasing to note that the excellent recovery and abundant new growth has resulted in a foliage which, in many parts, is considerably better than that of last year.

PERAK

In previous years, although the fungus was known to be present in Perak, no reports of leaf-fall have been received previous to 1934. This year leaf-fall was noted to be serious in two districts only—in the south (Slim—Tanjong Malim) and in the north—the areas around Trong. In both these widely-separated districts the earliest wintering trees had escaped attack while the later and main body of young leaf had opened during a period of unfavourable weather and appeared to be suffering heavily from this disease when observed in the middle of April. In some cases large branches or even the whole tree had been completely defoliated. There were, however, signs of recovery and vigorous new growth.

Trolak, just north of Slim, experienced an earlier wintering and many trees had obtained a good new foliage before the attack commenced. Occasional low branches of late-wintering trees had been affected but were recovering.

Further north, wintering had been somewhat earlier though uneven. Large, early-refoliated areas were in good condition; such poor foliage as was observed could often be attributed to soil conditions. Patches of late-wintering trees, obviously infected but showing signs of recovery, were encountered. Occasional trees had suffered considerable defoliation.

In the Kuala Kangsar district, refoliation was practically complete by the middle of April. Foliage was generally excellent although small areas showing poor foliage were observed on poor soil. Slight defoliation was observed in old rubber in this district.

Young rubber, below the age of 12—15 years, bore an excellent foliage which had not suffered from mildew attack.

On the coastal side of Perak, in the district of Matang, the worst-affected areas were to be found in the neighbourhood of Trong, near the foot of the Bubu hills. Here again many trees were suffering a heavy leaf-fall, while many trees were in the stage of refoilation when most damage could quickly be done. Even the earlier wintering trees showed signs of having been heavily attacked.

At Bruas, on the other side of the hill, trees had wintered late in patches; those already refoiliated had a good crown of healthy foliage. The later wintering trees were infected to a considerable extent in the lower and middle shaded branches.

The district round Sitiawan carried some thin-foliaged, old rubber, the younger material was however in good condition. Wintering throughout was uneven and patchy. In fields with flat, insufficiently-drained soil, bearing tall trees, many instances were noted of trees completely defoliated by the fungus. Inland, towards Parit, the rubber improved in foliage but the wintering had also been slow and uneven. Light infection and occasional fall of leaf from lower branches only were observed.

PROVINCE WELLESLEY

In this district refoilation was completed during early April. A mild attack of *Oidium* is stated to have occurred on some trees in March. Foliage generally is good, though occasional areas of poor soil or lalang areas were noted carrying a thin, pale, yellowish foliage. The presence of the fungus on young leaves was demonstrated.

KEDAH

Inland from Province Wellesley it was found that wintering had taken place much later and slower, having been interrupted by unseasonable weather conditions. In South Kedah wintering was found to be very uneven in the various districts. The younger rubber had obtained an excellent foliage, showing little signs of attack by *Oidium Heveae*. The older rubber, however, showed some thin-foliaged areas and leaf-fall in patches where wintering had taken place during a period of dull, showery weather. In such areas, lower and middle branches usually were most affected, but occasional trees, bordering a clearing or root disease area, were completely defoliated.

From Bukit Mertajam to Padang Serai the foliage generally was good with slight *Oidium* in lower branches. On approaching

Kuala Ketil district wintering had been more uneven and, although generally the upper crown of foliage was good, considerable defoliation in lower branches had taken place. The younger rubber, i.e. rubber below ten years of age, carried a good healthy foliage. In several four-year old clearings, though the foliage generally was good, spiders, mites and *Oidium Heveae* were together found on the lower heavily-shaded branches.

In the district of Kuala Muda, the attack appeared to have been stronger than elsewhere in Kedah. This is no doubt due to the hard laterite-gravel type of soil resulting in a slower growth of leaves and poor recovery from the disease. Patches of younger rubber on better soils were in good condition. Wintering was practically complete by the middle of April and the present condition of the foliage closely follows the quality of the soil within the planted area. Manured blocks of rubber, though carrying better foliage, had also been attacked in the leaves of the lower branches. Flowers had been plentiful, but seed was scarce, indicating a general attack of the inflorescence easily verifiable by microscopic examination.

Further north, in Gurun and Junun districts, the disease was less easily discernible but occasional trees had been attacked and partly defoliated in the lower branches. Most rubber areas in these districts had completely wintered and obtained an excellent dark green crown of foliage.

PAHANG

In this State leaf-fall was reported for the first time from a number of estates in the western districts. In the Raub district wintering was very late and patchy, individual fields and even trees being in different stages of wintering and refoliation when visited early in May. It was evident that the dull weather and excessive rainfall (over 40 inches in three months) had slowed up wintering and retarded refoliation of the trees, thus leaving them open to attack over a longer period. The infection however was rather mild, variation in soil conditions and topography of the land being the chief factors responsible for variation in quality of foliage. Earlier-wintering trees were usually in good healthy condition. It was noticeable that a general infection of foliage by mites, with or without *Oidium Heveae*, was common. In the Benta district the trees were in rather better condition; the rubber, being younger, both old and new green leaves were on the trees, giving some areas the appearance of having a particularly heavy foliage. Closer inspection revealed a mild attack of *Oidium* on the shaded foliage, but little if any leaf-fall was observed.

Approaching Kuala Lipis, it could be said that the new foliage was healthy, though many trees would probably not winter until August.

On the Benta—Jerantut road some small-holding rubber was observed in fair condition, though wintering was late and uneven. Slight infection was observed in localities having old and new leaf on the same tree.

Towards Bentong there was a gradual improvement in the condition of the foliage but again wintering was late and very uneven, and many trees would probably not winter until August as frequently occurs in Pahang. Such leafless trees as were examined were found to be in an advanced state of wintering. *Oidium* was usually to be found causing a mild fall of young leaf in the lower branches only. Similarly, in Karak and Mentakab, wintering was late as is usual in these districts. Slight *Oidium* infection and leaf-fall in lower branches of occasional trees were recorded.

Summary

It would seem therefore that, during the 1934 wintering and refooliating season, several factors have played a part in influencing the occurrence and severity of leaf-fall caused by *Oidium Heveae*.

1. Excessive rains throughout the country in January and February delayed the commencement of wintering.

2. Dull wet weather in March and April slowed up the wintering and refoilation in a very uneven manner, giving much variation in state of foliage from field to field.

3. Lack of sunshine in March and April retarded the maturation of the new young leaves which remained for a long time in the limp condition in which they are susceptible to attack by the mildew fungus.

4. Dull showery weather reduces the day temperatures and increases the humidity, thus favouring the growth and spread of the fungus (see *R.R.I. Journal* Vol. 4, No. 2, *Effect of Meteorological Factors on the Virulence of Oidium Heveae in Malaya*).

5. The rain increased the vigour of growth of the leading stems and leaves so that leaves up to six inches long were observed bearing a thick felt of fungus on the underside of the midrib region.

6. The similarity of weather conditions and prolonged wintering throughout the various districts have given the fungus a chance to develop sufficiently to cause a mild fall of leaf in practically every district in Malaya.

The general distribution of the fungus throughout Malaya has been known for some years but it is not until this year that

it has indicated its presence in many districts by causing a fall of young leaf. In previous years the chief effect of the fungus has been on the inflorescence, resulting in loss or complete absence of seed. Continuous wet weather, as experienced this year, is also unfavourable to flowering and seed-setting, independent of any attack by *Oidium Heveae*. The flowers fail to mature, rot and drop off without apparent fertilisation.

In regard to the problem of treatment of this disease it is of interest to record this year's experiences.

Owing to the inclement weather it was practically impossible to keep to the programme so as to give one round of treatment every seven days. Very frequently, sulphur applied during the morning would be to a great extent washed off by heavy rain soon after midday, and it is doubtful whether any prophylactic effects would result.

Further, the inability to dry the sulphur and the unreliability of the type of machine most generally used added greatly to the difficulties experienced by the managers of the estates carrying out the treatment.

Observational results at the end of the refoliation season have however been received from six estates. An average of these results is as follows:—

(a) *Non-dusted Areas*

Trees with inferior foliage as a result of disease	...	48 per cent
with a minimum of 29 per cent and maximum of 78 per cent		
Trees with satisfactory healthy foliage	...	40 per cent
with a minimum of 14 per cent and maximum of 61 per cent		
Trees not yet wintered	...	12 per cent
with a minimum of 2 per cent and a maximum of 24 per cent.		

(b) *Dusted Areas*

Trees with inferior foliage as a result of disease	...	24 per cent
with a minimum of 16 per cent and a maximum of 33 per cent		
Trees with satisfactory healthy foliage	...	66 per cent
with a minimum of 53 per cent and a maximum of 82 per cent		
Trees not yet wintered	...	10 per cent
with a minimum of 2 per cent and a maximum of 24 per cent		

These results, generally speaking, indicate a 50 per cent control of the disease by sulphur-dusting. This is fairly satisfactory considering the bad luck which these estates had with their machines, the wet sulphur and the unseasonable weather.

There are no results to hand which indicate any likely increase in yield of rubber from sulphur-dusted trees.

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PRELIMINARY OBSERVATIONS ON THE COAGULATION OF ALKALINE LATEX

BY

J. D. HASTINGS

Introduction

Various alternatives to the usual acetic and formic acid coagulants have been proposed for the coagulation of Hevea latex in estate practice, generally with the object of reducing production costs. A few have been favourably received and used to a small extent, but most have been rejected for various reasons, and acetic and formic acids are still almost universally used.

Satisfactory coagulation of latex in an alkaline medium is considerably more difficult than it is in the slightly acid condition in which coagulation normally takes place. The production of good sheet rubber from ammonia-preserved, creamed, or centrifugal skim latex by simple acid coagulation is very difficult, and in most cases impossible, as the coagulum is only suitable for crepe manufacture. This may be of no importance in the case of ammoniated or creamed concentrated latex as it is seldom necessary to coagulate either. With centrifugal skim latex containing up to 15 per cent dry rubber, or even more, depending on the type and efficiency of the centrifuge, the disposal of the skim becomes a problem. With the possibility of concentration by centrifugal means showing still further expansion, an alternative coagulant which will enable sheet rubber to be made from the skim becomes valuable, provided its effect on the rubber is not deleterious and the cost is reasonable.

The coagulation of latex in an alkaline medium is therefore under investigation with particular reference to the production of a coagulum which can be made into sheet rubber. Coagulation of the following types of latex has been subjected to a preliminary study:

- (a) centrifugal skim latex
- (b) creamed concentrate
- (c) preserved field latex.

In all cases the preservative used has been ammonia, and coagulation in the presence of other alkalis has not yet been

investigated. Although the work is incomplete it is considered that the preliminary results are sufficiently interesting to be placed on record.

Survey of Literature

In recent years, as a result of the use of preserved latex for industrial purposes both as concentrate and as normal latex, a considerable amount of information on coagulation has accumulated. Many of the methods described have particular application to various types of manufacturing processes in which compounded latex is often used. Reference is only made here to the literature concerning those methods which are of interest in connection with the problem under investigation.

R. G. Fullerton (1) discussing the coagulation of ammoniated latex observes that it is more sensitive to acid than is fresh latex, and that the first few drops of acid produce local clotting. R. G. James (2) says it is practically impossible to reproduce with preserved latex the slow type of acid coagulation used on the plantation. Investigations on the properties of the rubber prepared from ammoniated latex by acid coagulation have been made by O. de Vries and his co-workers (3). In all cases however the coagulum was creped. It was observed that the amount of acid required for coagulation was considerably in excess of that required to neutralize the ammonia present and to coagulate the same quantity of fresh latex. Similar observations were made at the Imperial Institute during investigations on crepe rubber prepared from ammoniated latex (4).

In the earlier days of the plantation rubber industry a considerable amount of work was done by Henri, Vernet and others on the use of salts for the coagulation of fresh latex, and it was observed that the effectiveness of the salt is largely determined by the valency of the positive ion. R. G. James states that the precipitation of the rubber particles by salt ions can take place in acid, neutral, or alkaline solution. The effect of the added salt solutions becomes increasingly greater as the pH of the latex approaches the isoelectric point. P. Scholz (5) working on the coagulating coefficient of a number of electrolytes, found that they are rather similar for fresh and ammoniated latex, especially after neutralization of the ammonia with sulphuric acid. The latex used in these experiments was very weak, being diluted to 3.5 per cent dry rubber content.

Coagulation is generally considered to be the coalescence of the flocculent rubber particles, first formed by the action of the coagulant, into a coherent clot of coagulum. With ammoniated latex this flocculent condition of the particles is produced without

further coalescence, when certain of the heavy metal salts are used as coagulants. Aluminium chloride and sulphate, which give normal coagulation with fresh latex, produce only a flocculation with ammoniated latex. C. C. Loomis and H. E. Stump (6) working with latex of 30—38 per cent dry rubber content preserved with 0.5 per cent ammonia, describe the creaming effect obtained with aluminium sulphate and salts such as zinc and lead acetates. The cream consists of small flocculent particles which are redispersed on stirring. This method of semi-coagulation is used in certain industrial processes where a discontinuous coagulum is required.

For certain manufacturing processes it is necessary to produce from compounded normal or compounded concentrated latex mixes, a continuous type of coagulum, similar in many respects to that produced in the coagulation of fresh latex. The ease with which the coagulant can be distributed and its coagulating speed are obviously important. A delayed-action type of coagulant, such as sodium silicofluoride, is often used in these circumstances. Sodium silicofluoride has been advocated as an alternative coagulant for the coagulation of fresh latex (7—10) and is said to be better in some respects than acids. In the manufacturing processes in which it is used, the speed of coagulation can be controlled by the degree of alkalinity in the mix or by the addition of some powder such as zinc oxide (11).

The delayed coagulating action of sodium silicofluoride with highly compounded concentrated latex mixes, was recently used during investigations on the use of latex mixes for rubber roadways (12).

There is, however, considerable difference between the coagulation of compounded latex and that of an uncompounded and dilute latex with which this investigation is mainly concerned. With technical mixes, coagulation is under greater control, because it is possible, by the judicious use of stabilisers, to facilitate compounding and also to adjust the latex to that condition of stability most suited to the particular coagulant used.

Formaldehyde when added to preserved latex in amounts more than sufficient to neutralise the ammonia present, will cause gelling. With uncompounded latex it is only effective if the ammonia content is not greater than 0.05 per cent (13). By adding a sensitising agent such as zinc sulphate, or ammonium sulphate, it is possible to bring about gelling with latex of higher ammonia content. The higher the alkalinity, however, the greater is the amount of formaldehyde required in excess of that needed to neutralize the ammonia present.

O. de Vries (14) states that papain contains a coagulating enzyme for latex which is active in an alkaline medium. A solution of papain was recently used by E. Rhodes and J. L. Wiltshire* for the coagulation of centrifuged skim. It is, however, difficult to say how far the modified properties of the resulting rubber are due to changes in the latex as a result of centrifuging, or to the proteolytic action of the papain. In this connection it may be noted that it is very difficult to dry and prepare normal sheet rubber from fresh latex by papain coagulation, while J. Groenewege (15) reports that rubber so prepared quickly becomes tacky.

A process has been described by H. Colloseus (16) for coagulation by means of salts, oxides, hydroxides of the alkaline earths or heavy metal salts, latex which has been previously treated with alkali or other bodies to form water-soluble compounds with the albuminoids. W. Spoon (17) discussing the methods considers it is not suitable for the coagulation of Hevea latex.

S. C. Davidson (18) has patented a method of coagulating latex preserved with alkalized phenols, (alkaline mixtures of cresols and isomers, cresylic acids and higher tar acids) by means of a mixture of magnesium sulphate, or magnesium chloride and commercial sulphuric acid. The coagulum is then immersed in boiling water to make it sufficiently pliable for machining. He mentions that the sulphate gives better coagulation than the chloride. This observation is of interest in connection with some of the experiments to be described.

Experimental

The difference between the coagulum obtained from ammoniated and fresh latex by coagulation with a solution of aluminium sulphate is one of degree rather than of kind; in both cases a clear serum can be obtained. It seemed probable that if the non-coherent flocculent particles which result in the case of the ammoniated latex could be made to coalesce uniformly, either immediately or within a reasonable time, it should be possible to deal with the final coagulum in the same manner as with that from fresh latex. Structural differences in the rubbers would no doubt exist, since the flocculent particles produced by the aluminium sulphate in ammoniated latex are considerably larger than those occurring in the coagulation of fresh latex, where the change from latex to solid coagulum involves the coalescence of extremely small floccules.

*Unpublished work.

CENTRIFUGAL SKIM LATEX

Attempts to effect the coalescence of the flocculent particles were made with a centrifugal skim latex by the addition of a solution of sodium silicofluoride together with aluminium sulphate. The skim latex used was 2½ months old, its D.R.C. 14.7 per cent and the ammonia content had been raised to 0.61 per cent for preservation. Varying amounts of a 0.5 per cent solution of sodium silicofluoride were added to the skim latex together with a 5 per cent solution of aluminium sulphate; no coherent coagulum resulted. Other salts, notably aluminium chloride, zinc chloride, barium chloride, sodium dihydrogen phosphate, and calcium chloride were tried with sodium silicofluoride but no better results were obtained. With magnesium chloride, however, a good coherent coagulum resulted and magnesium sulphate also showed promise. Results were sufficiently encouraging to continue with magnesium chloride and only a few experiments were made with other salts. It is quite possible that some of those which at first gave no indication of being successful will be found satisfactory on further investigation. This observation applies particularly to calcium chloride.

Table I gives the results of the addition of a mixture of different amounts of a 5 per cent. solution of magnesium chloride and a 0.5 per cent. solution of sodium silicofluoride to 100 cc. of skim latex.

TABLE I

Ref. No.	Volume of Coagulant per 100 cc. Skim Latex		Immediate Effect of the Coagulant on the Latex	Effect after 20 hours	
	5 per cent MgCl ₂ cc.	0.5 per cent S.S.F. cc.			
L 57/1	10	50	None	Latex thickened	
L 57/2	15	45	"	Coagulation, with coherent coagulum	
L 57/3	20	40	Latex thickened and flocculated	" "	
L 57/4	25	35	"	Coagulation with very "short" coagulum,	
L 57/5	30	30	"	" "	

The best coagulum appeared to be either L 57/2 or L 57/3. The coagulum was soft but coherent, while the serum was dark brown. From the appearance of a coagulum made under the trial coagulation conditions of the laboratory it is difficult to decide whether the same coagulum will be suitable for sheet manufacture when prepared on a larger scale. On several occasions larger-scale trials have given a coagulum which proved less easy to handle than was expected from the laboratory experiments. The magnesium chloride solution was mixed with the sodium silicofluoride solution before addition to the latex. When magnesium chloride was added first to the skim latex, local clotting occurred. The effect of the separate addition of the solutions was therefore examined.

A 0.5 per cent. solution of sodium silicofluoride added in amounts from 5 cc. to 100 cc. per 100 cc. of skim latex had no immediate effect and no coagulation had occurred by next day. The clotting which had been observed previously was therefore due apparently to the magnesium chloride. With a 5 per cent. solution of magnesium chloride clotting occurred immediately. The clotting was similar to that produced with acid. By using a weaker solution of magnesium chloride this local clotting was prevented. Dilution of the magnesium chloride is, in fact, achieved by mixing the sodium silicofluoride solution with the magnesium chloride solution before addition to the latex.

TABLE II

Ref. No.	Coagulant Solution containing per 100 cc. Skim Latex		Immediate Effect of the Coagulant on the Latex	Effect after 20 Hours
	5 per cent MgCl ₂ cc.	Water cc.		
L 66/1	15	0	Severe local coagulation	No further change
L 66/2	15	10	" " "	" "
L 66/3	15	20	Local coagulation	" "
L 66/4	15	25	Slight local coagulation	" "
L 66/5	15	30	No local coagulation	No coagulation
L 66/6	15	45	" " "	" "

Table II gives the results of diluting a fixed volume of 5 per cent. magnesium chloride solution before addition to 100 cc. of skim latex.

It is seen from sample L 66/5 in the above table that the addition of a solution of magnesium chloride stronger than 1.6 per cent., caused local clotting when added to this sample of skim latex. As samples Nos. L 57/2 and L 57/3 (Table I) gave good coagulum, the volumes of magnesium chloride used in experiments with this sample of skim latex were kept constant while variations were made in the amounts of sodium silicofluoride added to these volumes before mixing with the skim latex. The results are shown in Table III.

TABLE III

Ref. No.	Volume of Coagulant per 100 cc. Skim Latex		Immediate Effect of the Coagulant on the Latex	Effect after 20 Hours
	5 per cent MgCl ₂ cc.	5 per cent S.S.F. cc.		
L 64/1 A	15	20	Local coagulation	No further coagulation
L 64/1 B	15	25	" "	" " "
L 64/1 C	15	30	No local coagulation	" " "
L 64/1 D	15	35	" "	Coagulation, coherent coagulum
L 64/1 E	15	40	" "	" " "
L 64/1 F	15	45	" "	" " "
L 64/2 A	20	20	Local coagulation	No further coagulation
L 64/2 B	20	25	" "	Coagulation
L 64/2 C	20	30	Thickening, slight local coagulation	"
L 64/2 D	20	35	Flocculation, slight local coagulation	Coagulation, coagulum "short"
L 64/2 E	20	40	Flocculation, no local coagulation	" " "

Although a coherent coagulum with a clear serum was obtained in L 64/1 D it was extremely soft and such a coagulum could not be handled for the manufacture of sheet. L 64/1 E and L 64/1 F were also soft but firmer than L 64/1 D. With L 64/2 D and L 64/2 E the coagulum was of a different type. The flocculent particles had united to form a coagulum which, although coherent, had an open texture comparable to a sponge and was easily torn. This type of coagulum appeared to result when flocculation happened immediately after addition of the coagulant mixture.

In general the greater the degree of flocculation the "shorter" the coagulum. In cases where this happened, coagulation was very rapid, and separation into serum and coagulum was complete in a few hours.

Factory coagulation in coagulating pans was tried using the coagulant proportions found most promising in the trial coagulations. Pans containing half a gallon of skim latex together with mixtures of the following proportions were prepared:—

L 67/1 12 fluid ounces of 5 per cent. magnesium chloride solution and 32 fluid ounces of 0.5 per cent. sodium silicofluoride solution

L 67/2 12 fluid ounces of 5 per cent. magnesium chloride solution and 36 fluid ounces of 0.5 per cent. sodium silicofluoride solution

L 67/3 16 fluid ounces of 5 per cent. magnesium chloride solution and 24 fluid ounces of 0.5 per cent. sodium silicofluoride solution.

These amounts correspond to the proportions in L 64/1 E, L 64/1 F, and L 64/2 C (Table III). With L 67/1 and L 67/2 no local clotting took place. A slight thickening was noticeable however while the coagulant was being stirred into the latex. With L 67/3, rapid thickening occurred; flocculation had started before the surface bubbles had been removed from the pans, and a soft coagulum was formed in half an hour.

The latex in all the pans coagulated overnight but there were differences in the coagulum. Within each of the three series of experiments the hardness of the coagulum varied as well as the condition of the serum. In some pans the serum was clear and dark brown in colour, while in others the colour was dirty brownish white. The coagulum of L 67/1 and L 67/2 was slippery and somewhat difficult to handle, especially during the first few machinings. Considerable care in machining was necessary but, once the machine settings for the various stages were determined, it was possible to prepare good sheet rubber.

The unexpected variation in hardness of the coagulum from pan to pan in the same series was disturbing. A number of possible reasons for this variation suggested themselves and these were tested experimentally but without success; the precise cause of the variation remains for the present, therefore, obscure.

In the latter experiments, it was found that the magnesium salt and the sodium silicofluoride could be applied as a single solution and that the mixture used in sample L 67/1 was effective. This solution contained 1.36 per cent of magnesium chloride

TABLE IV

MgCl₂—S.S.F. Solutions with diluted Skim Latex
D.R.C. 7.3 per cent. NH₃ content 0.3 per cent.

Ref. No.	Coagulant Solution containing		Volume of Coagul- ant per 100 c.c. of Latex c.c.	Immediate Effect of the Coagulant on the Latex	Effect after 20 Hours
	MgCl ₂ per cent	S.S.F per cent			
L 76/1	1.36	0.36	30	None	No coagulation
/2	"	"	35	"	"
/3	"	"	40	"	Coagulation : soft coagulum, serum clear
/4	"	"	45	Flocculation soon after addition	Coagulation : "short" coagulum, serum clear
/5	"	"	50	Flocculation immediately after addition	"
L 79/1	1.50	0.25	20	None	No coagulation
/2	"	"	25	"	"
/3	"	"	30	"	"
/4	"	"	35	"	"
/5	"	"	40	"	"
L 80/1	1.25	0.50	20	None	No coagulation
/2	"	"	25	"	"
/3	"	"	30	"	"
/4	"	"	35	"	"
/5	"	"	40	"	Coagulation : very soft coagulum

TABLE IV—(contd.)

Ref. No.	Coagulant Solution containing		Volume of Coagu- lant per 100 cc. of Latex cc.	Immediate Effect of the Coagulant on the Latex	Effect after 20 Hours
	MgCl ₂ per cent	S.S.F. per cent			
L 77/1	1.25	0.75	20	None	No coagulation
/2	"	"	25	"	"
/3	"	"	30	Flocculation soon after addition	Coagulation: "short" coagulum, serum clear
/4	"	"	35	Flocculation immediately after addition	Coagulation: "short" coagulum, serum clear
/5	"	"	40	"	Coagulation: very "short" coagulum, serum clear
L 81/1	1.75	0.25	20	None	No coagulation
/2	"	"	25	"	"
/3	"	"	30	"	"
/4	"	"	35	"	"
/5	"	"	40	"	"
L 82/1	1.75	0.50	20	None	No coagulation
/2	"	"	25	"	"
/3	"	"	30	Flocculation soon after addition	Coagulation: very soft coagulum, serum clear
/4	"	"	35	Flocculation immediately after addition	Coagulation: soft coagulum, serum clear
/5	"	"	40	do.	Coagulation: very "short" coagulum, serum clear

TABLE IV—(contd.)

Ref. No.	Coagulant Solution containing		Volume of Coagulant per 100 cc. of Latex cc.	Immediate Effect of the Coagulant on the Latex	Effect after 20 Hours
	MgCl ₂ per cent	S.S.F. per cent			
L 83/1	1.75	0.75	10	None	No coagulation
/2	"	"	15	"	"
/3	"	"	20	"	"
/4	"	"	25	"	Coagulation: very soft coagulum, serum clear
/5	"	"	30	Flocculation immediately after addition	Coagulation: soft coagulum, serum clear
L 84/1	2.00	0.75	5	None	No coagulation
/2	"	"	10	"	"
/3	"	"	15	"	"
/4	"	"	20	"	"
/5	"	"	25	Flocculation soon after addition	Coagulation: "short" coagulum, serum clear

together with 0.36 per cent of sodium silicofluoride. A coagulum which could be converted to sheet was obtained by using 88 ounces of the solution per gallon of latex. The sheet rubber, after drying in hot air at a temperature of 120°—130°F, was of excellent appearance and free from bubbles and stickiness. It is worthy of note that in the case of sheet rubber prepared in the Institute by papain coagulation of skim latex from the same source, the rubber was much softer, inclined to be tacky and much more difficult to dry.

EXPERIMENTS WITH DILUTED CENTRIFUGAL SKIM LATEX

The experiments described above were made with a sample of skim latex having the comparatively high D.R.C. of 14.7 per

cent and the coagulation of a diluted skim made from it, was next considered. The skim latex was diluted with an equal volume of water and treated with varying amounts of solutions containing magnesium chloride and sodium silicofluoride in different proportions. The results are given in Table IV.

The indications were that satisfactory coagulation should result from the application of 40—45 cc. of a coagulant containing 1.36 per cent magnesium chloride and 0.36 per cent sodium silicofluoride to 100 cc. of latex, which corresponds to 64—72 fluid ounces per gallon of latex. In larger-scale pan coagulation an amount of coagulant equivalent to 68 fluid ounces per gallon of diluted skim latex was found to give a coagulum which, although too soft for immediate machining, was easily handled after soaking for 24 hours in water.

The diluted skim latex required, therefore, as might have been expected, a smaller amount of the coagulant than the parent skim, but the coagulum obtained was less compact. The trials with this sample of diluted skim latex indicated that, after dilution, it was much less sensitive to magnesium chloride than the parent skim latex. The addition to the parent skim latex of solutions containing more than 1.6 per cent magnesium chloride resulted in immediate clotting, but the once-diluted skim was tolerant to magnesium chloride solutions up to a concentration of 2.75 per cent.

UTERMARK SKIM LATEX OF LOW INITIAL DRY RUBBER CONTENT

Attention was next directed to the coagulation of skim latex from a centrifuge of somewhat higher efficiency. Such a skim latex would have a greater concentration of non-rubber solids than a diluted latex made from a skim of high original dry rubber content, and the coagulation phenomena were not expected to be identical. By courtesy of Dunlop Plantations Ltd., it was possible to obtain for trial a skim latex of suitably low dry rubber content. In order to ensure safe transport, however, the ammonia content was of necessity increased considerably above that of normal skim latex as it emerges from the centrifuges. In small-scale trials it became apparent that the Utermark skim latex was much less sensitive to magnesium chloride and sodium silicofluoride than the richer skim latex previously examined. It was therefore found necessary to employ coagulants of which the two components were present in considerably higher concentrations. The results of a series of pan coagulations with coagulants of various concentrations are set out in Table V.

TABLE V

Coagulation of Utermark Skim Latex
D.R.C. 10.7 per cent. NH_3 content 0.70 per cent.

Ref. No.	Coagulant Solution containing		Volume of Coagu- lant per gallon of Latex oz.	Immediate Effect of the Coagulant on the Latex	Effect after 20 Hours
	MgCl ₂ per cent	S.S.F. per cent			
L 86/12/1	2.0	0.6	50	None	Coherent coagulum in clear brown serum: Coagulum had a number of bad cracks which made sheeting impossible
L 86/12/2	"	"	55	Slight flocculation	Similar but coagulum was "shorter"
L 86/13/1	2.25	0.6	45	None	Coherent coagulum in clear serum but badly cracked
L 86/13/2	"	"	50	Slight flocculation	" " "
L 86/13/3	"	"	54	Flocculation	Coagulum very "short", easily torn
L 86/14/1	2.50	0.6	42	None	No coagulation: latex thickened only
L 86/14/2	"	"	45	Slight flocculation	Coherent coagulum made into sheet, serum not so clear
L 86/14/3	"	"	50	Flocculation	Coagulum too "short" to machine

Good air-dried sheet rubber, free from bubbles and of excellent general appearance was prepared from the coagulum L 86/14/2 of which the coagulant dose was 45 fluid ounces of a solution containing 2.5 per cent magnesium chloride and 0.6 per cent sodium silicofluoride per gallon of skim latex.

It was observed by trials that, on storage, the reaction of the skim latex to the coagulant mixtures is modified and that a dose

of coagulant which is effective on a certain day, when applied a few days later gives an unsuitable coagulum.

Trials in small experimental tanks also indicated that in general the quality of the product from tank coagulation is slightly better than that from coagulation in pans. This is probably due to the fact that the cohesion of the initial flocculates is improved by a self-compacting of the coagulum while standing overnight in comparatively deep vessels.

That variations in one or more of the factors, dry rubber content, ammonia content, and non-caoutchouc constituents of different samples of skim latex, may produce variation in their response to the coagulant mixture, is illustrated by experiments made on another sample of Utermark skim latex, of which the dry rubber content and ammonia content were different from those of the first sample. It was at once found that proportions of coagulant which gave a satisfactory sheet coagulum with the first sample were unsuitable for the coagulation of the second, and a series of laboratory trials were accordingly made with a range of sodium silicofluoride—magnesium chloride coagulants and also with a range in which magnesium sulphate was substituted for the chloride. The more important results are set out in Table VI and indicate that by the use of magnesium sulphate in suitable proportion, slightly better results might be expected than by the use of magnesium chloride. Subsequent large-scale trials confirmed this finding and good sheet was eventually produced by its use in tank and pan coagulation.

In tank coagulation there is a tendency for bubbles of air or ammonia to be entrained in the spongy coagulum and to be locked therein during the early stages of machining. With a reduction of thickness in the later stages of machining, quite large blisters may be observed which may or may not burst on the last smooth roll or on the marking roll. The loss of entrained gas or air is also largely responsible for the extreme shrinkage which invariably takes place in the skim latex sheet on drying.

CREAMED LATEX

Preliminary trials were next made with creamed latex and for the initial experiments a gum tragacanth cream having a D.R.C. of 51 per cent and an ammonia content of 0.67 per cent was used. The cream had been prepared a little over a month and was diluted to 15 per cent D.R.C. before use. At this dilution it was very sensitive to magnesium chloride and small-scale trials indicated that for satisfactory coagulation the most suitable solution would be that containing 1.36 per cent magnesium chloride and 0.36 per cent sodium silicofluoride.

TABLE VI

Coagulation of Utermark Skim Latex
D.R.C. 12 per cent. NH_3 content 0.57 per cent.

Ref. No.	Coagulant Solution containing			Volume of Coagu- lant per 100 cc. of Latex cc.	Immediate Effect of the Coagulant on the Latex	Effect after 20 Hours
	MgCl ₂ per cent	MgSO ₄ per cent	S.S.F. per cent			
L 111/A1	2.5	—	0.6	20	None	No coagulation
/A2	"	—	"	25	"	"
/A3	"	—	"	30	"	Coagulation: soft coagulum, serum dirty white
/A4	"	—	"	35	"	Coagulation: soft coagulum, serum dirty white
/A5	"	—	"	40	"	Coagulation: cracked coagulum, serum clear
L 111/B1	2.7	—	0.7	20	None	No coagulation
/B2	"	—	"	22½	"	"
/B3	"	—	"	25	"	"
/B4	"	—	"	27½	"	Apparent coagulation: flocculent, redispersible coagulum
/B5	"	—	"	30	"	Apparent coagulation: flocculent, redispersible coagulum
L 111/C1	3.0	—	0.6	20	None	No coagulation
/C2	"	—	"	25	"	"
/C3	"	—	"	30	"	Coagulation: soft coagulum, serum dirty white
/C4	"	—	"	35	Flocculation shortly after addition	Coagulation: soft coagulum, serum clear

TABLE VI—(contd.)

Ref. No.	Coagulant Solution containing			Volume of Coagu- lant per 100 cc. of Latex cc.	Immediate Effect of the Coagulant on the Latex	Effect after 20 Hours
	MgCl ₂ per cent	MgSO ₄ per cent	S.S.F. per cent			
L 111/C5	3.0	—	0.6	40	Flocculation shortly after addition	Coagulation : "short" coagulum, serum clear
L 111/D1	—	3.0	0.5	25	None	No coagulation
/D2	—	"	"	30	"	"
/D3	—	"	"	35	"	Coagulation : soft coagulum, serum dirty white
/D4	—	"	"	40	"	Coagulation : firm coagulum, serum clear
/D5	—	"	"	45	"	Coagulation : "short" coagulum, serum clear
L 111/E1	3.5	—	0.3	25	None	No coagulation
/E2	"	—	"	30	"	"
/E3	"	—	"	35	"	"
/E4	"	—	"	40	Flocculation shortly after addition	Coagulation : soft coagulum, serum clear
/E5	"	—	"	45	Flocculation shortly after addition	Coagulation : "short" coagulum, serum clear
L 111/F1	—	3.5	0.3	25	None	No coagulation
/F2	—	"	"	30	"	"
/F3	—	"	"	35	"	"
/F4	—	"	"	40	"	"
/F5	—	"	"	45	"	"

The following series of pan experiments was made with varying amounts of this coagulant solution:—

Volume of Coagulant Solution in fluid ounces added to one gallon of creamed Latex diluted to a D.R.C. of 15 per cent.

Sample	L88/1A	L88/1B	L88/1C	L88/1D	L88/1E	L88/1F	L88/1G	L88/1H
Volume added	48	50	52	54	56	58	60	62

No coagulation took place with L 88/1A, while L 88/1B and L 88/1C gave coagulum too soft for successful handling on sheeting rolls and the serum was very milky. From L88/1D onwards the coagulum was firmer and the serum progressively clearer, until with 62 fluid ounces per gallon it was quite clear. The coagulum was easily machined and the resulting sheets were of excellent appearance, although when dried at 120°—130°F they were sticky and soft. When the cream was diluted with one and a half volumes of water to one volume of cream, giving a little higher D.R.C., 62 fluid ounces of coagulant per gallon still gave good coagulation. Coagulation in a tank gave coherent coagulum of which the upper edges were firmer than the lower edges; on this account it was difficult to avoid tearing the sheets in the later stages of machining. With another sample of cream, having a D.R.C. of 52 per cent, and an ammonia content 0.60 per cent, coagulation under similar conditions gave a satisfactory coagulum and good sheet, although blisters due to occluded gas gave trouble in machining.

AMMONIATED LATEX

(i) *Preserved dilute Latex*

Laboratory trials were first made with latex which had been diluted to a D.R.C. of approximately 15 per cent and preserved for 22 weeks with 0.5 per cent ammonia. Small-scale trials indicated that the most suitable coagulant solutions would be

- (a) a solution containing 2.5 per cent magnesium chloride and 0.6 per cent sodium silicofluoride
- and (b) a solution containing 3.5 per cent magnesium sulphate and 0.3 per cent sodium silicofluoride.

The following pan coagulations were made with the second coagulant solution:—

Volume of Coagulant Solution in fluid ounces added to one gallon of preserved dilute Latex of Dry Rubber Content 14 per cent.

Sample	L104/6A	L104/6B	L104/6C	L104/6D
Volume added	38	36	34	32

Good coagulation resulted, but the serum from L 104/6C and L 104/6D was not so clear as the others. Coagulation was very rapid, and in all cases good coagulum had formed within an hour. On standing overnight considerable contraction occurred in the coagulum. The dried sheets were extremely sticky and soft. The serum had a strong odour of ammonia and samples taken from a number of pans of L 104/6A and L 104/6B were found to contain 0.28 to 0.30 per cent of ammonia. Similar results were obtained with a similar latex which had been preserved for eleven weeks. In this case, however, the dry sheets were less soft and sticky. The same coagulant solution was found to be effective for similar dilute latex preserved for shorter periods but, where the preservation period was of the order of 1—7 days, the coagulum was undesirably soft and the serum cloudy.

(ii) *Preserved field Latex*

Field latex preserved with 0.5 per cent ammonia and stored for 24 hours was effectively coagulated with the coagulant solution containing 3.5 per cent magnesium sulphate and 0.3 per cent sodium silicofluoride, when applied in the proportion of 60 fluid ounces of coagulant to one gallon of undiluted preserved field latex. The effect of longer storage on the reaction of field latex to this coagulant mixture was next considered, and in the course of the examination, good sheet rubber was produced from undiluted preserved field latex which had been stored for periods of five days, one month, two months and three months respectively. The amount of coagulant required was in general slightly larger, and of the order of 70 fluid ounces per gallon of latex. The coagulum, although obtained from latex containing well over three pounds of dry rubber per gallon, was remarkably plastic and therefore easily machined into a thin sheet.

Until many more samples of stored latex have been examined, it cannot be said with certainty that preserved latex from any

source and of any age will be readily amenable to smooth coagulation, but the indications at the present stage are promising.

FRESH LATEX

Magnesium chloride—sodium silicofluoride mixtures have been applied to the coagulation of fresh latex in the undiluted condition and at many dilutions down to a dry rubber content of 10 per cent or approximately 1 lb. per gallon. Excellent coagulation has always resulted. Coagulation is more rapid than when sodium silicofluoride is used alone, and the rate of coagulation increases with increase in the concentration of magnesium chloride in the mixture. Coagulum machined on the following day is slightly softer than formic acid controls, and with similar machining procedure yields sheets of which the area is 7 to 10 per cent larger.

Preliminary vulcanisation tests indicate that sheet rubber prepared by the use of magnesium chloride—sodium silicofluoride mixtures is slightly slower-curing than rubber prepared by the use of formic acid.

Discussion

It has been shown that preserved latex, whether in the form of normal field latex, latex concentrate or centrifugal skim latex, is an extremely difficult medium for the attainment of that smooth and accurate coagulation which is essential in the manufacture of sheet as distinct from crepe rubber. The preservative present produces progressive changes in the non-rubber constituents which result in progressive changes in the reaction of the latex to coagulants. The rate at which these changes take place is dependent to some extent on the amount of alkali present as well as upon time, so that, from the point of view of coagulation, the term "preserved latex", even when applied to preserved field latex coagulated shortly after collection, covers a range of fluids of very great variability. The present preliminary investigation has revealed coagulant mixtures by the use of which the desired smooth coagulation can be achieved and good sheet rubber prepared from numerous forms of preserved latex. It has unfortunately also demonstrated that, although it is comparatively easy to induce a smooth, quick and clean coagulation giving a coagulum which is quite suitable for the manufacture of crepe rubber, the limits between which this coagulum is of a texture suitable for sheet manufacture are very narrow. Inherent variability, coupled with the changes which take place on storage, make it impossible to predict the precise concentration and amount of the coagulant which will yield a coagulum of just the right

texture for sheet manufacture. It has been demonstrated however that, if preliminary trials are made in order accurately to determine quantities for each individual sample, sheet rubber can be produced from almost any form of preserved latex. In general the minimum quantity of coagulant produces a coherent coagulum which is so soft that it cannot be handled without distortion. Such a coagulum is unsuitable for sheet manufacture. As the amount of coagulant is increased, the coagulum becomes firmer. Further increase in the amount produces a coagulum which is "short" and, if too great an excess is used, the coagulum may become so "short" that coherence is entirely lost. In the manufacture of sheet rubber from skim latex the best results are usually obtained from coagulum which is reasonably firm but which shows some signs of "shortness". When dealing with creamed or normal ammoniated latex, coagulum which is firm without being "short" can be handled without much difficulty. Where it is desired to manufacture crepe rubber the problem of a suitable texture of coagulum largely disappears, and any of the coagulum, except that which is completely non-coherent, can be satisfactorily treated.

It has not so far been possible to attempt the coagulation of fresh centrifugal skim latex of low ammonia content and it is therefore not possible to state with certainty whether day-to-day variations in dry rubber content and physico-chemical condition of the skim would render this method of coagulation unsuccessful for the routine manufacture of skim latex sheet rubber. It seems fairly certain, however, that it could be applied to the manufacture of skim latex crepe rubber without great difficulty.

It seems probable also that where, as happens occasionally, estates wish to produce a marketable rubber from old stocks of unsaleable ammoniated or creamed latex, the use of coagulant mixtures of this type might prove useful. It should again be emphasised, however, that preliminary small-scale trials would be necessary.

Although the coagulant mixtures described give good results with fresh latex it is improbable that they will find an application in estate practice because of their corrosive action on aluminium.

The results recorded are only a preliminary survey of the coagulation of alkaline latex. They indicate that mixtures of sodium silicofluoride with magnesium chloride or sulphate, and possibly with other salts can be used for the purpose. A more detailed examination of the problem is necessary to determine whether some of the findings can find useful application in estate practice.

Summary

1. Mixtures of sodium silicofluoride and magnesium chloride or sulphate can be used for coagulation of alkaline latex.
2. The production of a coagulum suitable for sheet manufacture is described.
3. Preliminary experiments on the coagulation of centrifugal skim latex, creamed latex and ammoniated latex are described.

Acknowledgement

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Kuala Lumpur,

24th August, 1934

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THE PACKING OF RAW RUBBER

BY

A. MOORE

Introduction

Although the slump of the last few years has caused many economies to be made in almost every side of the rubber growing industry, nearly all estates continue to export their rubber packed in expensive wooden cases in spite of the fact that there are cheaper and easier methods of packing which are equally suitable.

In an article in the *Journal of the Rubber Research Institute*, Vol. 4, No. 1, July, 1932, B. J. Eaton described in some detail the use of hessian cloth and mengkuang matting as materials in which to bale raw rubber and showed that packing in wooden cases was an unnecessary expense. The use of cases however continues to be as extensive as before, so that it appears desirable to draw attention once more to the advantages of baling and also to describe some newer methods of packing rubber, notably in paper sacks, which are only just being introduced.

It is outside the scope of this article to enquire into the reasons for the insistence on estate rubber being packed in cases. It is, however, pertinent to remark that probably well over half of the rubber exported from Malaya is packed in bales, including remilled native rubber, and that large manufacturers purchasing direct prefer bales to cases.

BALING IN HESSIAN (BURLAP) OR GUNNY

Hessian and gunny are the two materials most commonly in use at the present time. Hessian is used new, being bought either direct from India or through merchants in this country, whilst the gunny used is generally old rice sacks suitably cut.

Before they can be used for wrapping bales of rubber both of these materials must be treated with a size, to increase their strength and to prevent fibres from sticking to the outside of the rubber. A suitable size consists of:—

Tapioca flour ...	...	...	120 lb.
Silicate of Soda	...	...	7½ „
Water	...	...	120 gallons

The above quantity is sufficient to treat 850 yards of hessian 45 inches wide, and the work of treating can be accomplished by

five labourers in one working day. The size is contained in a shallow tank fitted with rollers underneath which the hessian is drawn by winding it on a simple revolving frame, excess of size being scraped off by boards fixed at the edge of the tank. After being dipped in this way the hessian is unwound and hung out to dry before being cut into lengths suitable for wrapping bales of rubber. The whole process is very cheap and easy.

Gunny is treated in much the same way, but being already in separate pieces the work takes a little longer. Also owing to its greater thickness, gunny absorbs rather more size than does hessian.

As a further precaution against adhesion of fibres the outside of the rubber and the inside of the baling material should be dusted with talcum powder.

The cost of sufficient hessian or gunny to wrap one standard bale of raw rubber, treated with size and cut ready for use, is in round figures about 20 cents. If sheet is being baled it is often not considered necessary to strap it with steel tapes, which are required when baling crepe, but if straps are used the extra cost is 10—12 cents per bale. It is quite easy to press 250 lb. of sheet rubber into a bale of the same size and shape as a standard case holding 224 lb., which further emphasizes the economy of baling as against packing in cases.

BALING IN "GRASS" MATTING

Mats made of such materials as mengkuang palm fibre can be used for baling rubber. No treatment with size is needed, but it is advisable to dust the rubber, and the inside of the matting, with talcum. This method of baling is not greatly favoured, as it is stated that such matting does not withstand handling with hooks so well as do hessian or gunny, and in addition the packages are rather more bulky and untidy.

The cost of sufficient mengkuang matting to wrap a standard bale is about 18 cents, to which must be added the cost of straps, if these are considered necessary.

One considerable advantage which would follow the use of mengkuang matting for baling rubber would be the development of a mat-making industry amongst the natives of Malaya, who already make such mats on a small scale for their own domestic use. It is further suggested that small holders might use mats of their own making to wrap their rubber whilst taking it to the local dealer. Native sheet is very often reduced in value by being transported loose on the back of a car or a bicycle, and a wrapper of mengkuang matting, which could be used many times,

would protect it from contamination by dust and enable the owner to obtain a higher price.

BALING WITHOUT ANY WRAPPING

This method has not been widely practised and is only suitable for large consumers shipping direct to their own factories. The sheet rubber is simply made into a bale, preferably with wrapper sheets of the same quality, strapped with three or four steel tapes, and dispatched. On arrival at its destination the rubber requires to be cleaned thoroughly, so that this method of packing is acceptable only to consumers possessing adequate cleaning machinery.

BALING IN PLY-PAPER

This new baling material is only now becoming available. It consists of a number of plies of paper stuck together with latex, and it is hoped to manufacture it in this country from imported paper.

The material is surprisingly strong, and is claimed to be water-proof. A single piece of it is used to wrap a standard bale of sheet rubber, just as a parcel is wrapped, and the folded ends are further secured by sticking on to each a square piece of the ply-paper. Latex is used as an adhesive to seal the seams and ends. No stitching is required and the finished parcel is completely sealed so that no dust can enter.

The cost of this ply-paper is not yet known, but it will certainly be less than that of the usual wooden cases.

PACKING IN PAPER SACKS

The use of paper sacks for packing rubber is also a recent development, and is one which promises to become of considerable importance. In January 1934 the Rubber Research Institute packed and dispatched to London a small quantity of sheet rubber in paper sacks, and this was followed by a consignment of about 25 tons from an estate in Malacca. These consignments, and one other in which various baling materials were used, were examined on arrival by the technical staff of the London Advisory Committee for Rubber Research (Ceylon and Malaya), and as their report and conclusions are of great interest they are reproduced in full in Appendix "A".

The work of packing in paper sacks is very easy, the sheet being packed and pressed in an ordinary mould and the two halves of the paper sack slipped over the block of rubber thus obtained. The maker's standard instructions for packing in paper sacks are reproduced in Appendix "B". No mention is

made there of dusting the outside of the block of rubber with talcum, but this is very necessary as otherwise the paper might stick to the rubber (See Appendix "A").

Paper sacks are now being sold in Malaya at a cost of 25 cents for a sack to hold 112 lbs. of rubber. It is probable that if they came into general use the cost would be appreciably reduced.

PACKING IN WOODEN CASES

Everyone is familiar with the 3-ply wooden cases still commonly used for packing estate rubber, so it is not proposed to discuss them in detail. Their principal disadvantages are high cost and the danger of splinters getting into the rubber. Their principal advantages are that they completely exclude dirt and are almost water-proof.

The average cost of a case to hold 224 lb. of sheet rubber, assembled and ready for use, is in the neighbourhood of 70 cents.

On some estates up to 250 lb. of sheet rubber is packed in a case. If this is done carefully, and the rubber well pressed, there should be a saving in freight charges, but often the cases bulge so much that extra shipping charges are incurred which lessen the saving that would otherwise be made.

It might be remarked in passing that many estates packing in cases make the mistake of nailing the battens at top and bottom to the *sides* of the case. The battens should be nailed to the *ends* of the case, as this facilitates opening for the purpose of inspection and sampling.

DUSTING OF RUBBER DURING PACKING

It has been mentioned above that, when baling, the outside of the block of rubber and the inside of the wrapper should be dusted to prevent sticking.

For this purpose ordinary talcum, costing about \$40/- per ton, is quite suitable, and about two ounces is required for each 2-cwt. bale, i.e. the cost is about one quarter of a cent per bale.

The talcum is contained in a small muslin bag which is shaken and rubbed lightly over the surface of the rubber and the inside of the baling material immediately before wrapping.

Recently various small manufacturers, who are not equipped with machinery for cutting up blocks of rubber, have asked for bales or cases of rubber in which each sheet is dusted separately as it is packed. This dusting prevents massing in transit and in storage, and the sheets in each package can easily be separated by hand (see Appendix "A").

In the experimental consignments so far prepared the dusting powder used has been zinc stearate or a mixture of this with magnesium oxide. From one half to one pound of dusting powder is required to dust every sheet in 2 cwt. of rubber, and as the cost of zinc stearate is about 80 cents per pound the process is rather expensive. It can, in fact, only be practised at the express request of a consumer who is willing to pay a sufficient premium for rubber so treated.

Recently an estate near Kuala Lumpur prepared, by agreement with the purchaser, a consignment of several tons of sheet rubber packed in cases in which every sheet was specially dusted with zinc stearate. The zinc stearate was supplied by the purchaser, and it was found that 112 lb. was sufficient to dust every sheet in 11 tons of rubber. The cost of the extra labour required for dusting was estimated at \$1/- per ton of rubber, but it is considered that with improved dusting equipment both the labour and the amount of zinc stearate used could be reduced by at least one-third.

The rubber on arrival received a good report, and the premium obtained amply covered the cost of dusting.

Summary

In the appended table the approximate costs of packing rubber in various ways are summarised, together with brief remarks on any special advantages or disadvantages of each method.

To the costs of 1, 2 & 3 should be added 10—12 cents for steel straps, if the buyers demand that these be used.

Conclusions

Packing raw rubber (except such specialities as sole crepe and superfine pale crepe) in wooden cases is an unnecessary expense.

Other methods of packing can be used which are cheaper and easier and also are as good or better. This is proved by the fact that large manufacturers buying and shipping direct prefer bales to cases.

Kuala Lumpur

30th October, 1934

Method of Packing		Approximate cost of standard package 224—250 lb, excluding labour of packing	Chief Advantages	Chief Disadvantages
1	Hessian	20 cents	Cheapness	Possible penetration by dust and water. Adherence of fibres
2	Gunny	20 cents	Cheapness	Possible penetration by dust and water. Adherence of fibres
3	Mengkuang matting	18 cents	Cheapness. Material could be made locally	Not water-proof. Tears too readily
4	No wrapping of any kind	12 cents for strapping	Cheapness	Rubber gets very dirty. Unsuitable except for large manufacturers
5	Ply-paper	Not fixed	Strong and water-proof. Latex used in making material	Possibly cost will prove too high compared with (6)
6	Paper Sacks	50 cents (2 bags)	Each package 112 lb. and easily handled. Relatively cheap compared with cases. Dust proof	Paper would soften if wet
7	Wooden 3-ply cases	70 cents	Dust proof, and not easily damaged by dampness	High cost. Splinters in rubber

Appendix "A"

LONDON ADVISORY COMMITTEE FOR RUBBER RESEARCH (CEYLON AND MALAYA)

Packing Experiments

The technical staff of the London Advisory Committee has recently examined three different consignments of smoked sheet in connection with packing experiments, two of which were small-scale experiments organised by the Rubber Research Institute, Malaya, and the other a large-scale experiment organised by a member of the Rubber Growers' Association.

Two of the trials were concerned with a paper sack which it is claimed by the manufacturers is suitable for rubber. The other was concerned with different types of baling material. Several rubber manufacturers in this country are understood to be interested in the treatment of rubber with a surface lubricant and all three experiments included rubber dusted at least on the outside of the wrapping sheets.

The first consignment examined was forwarded by the Rubber Research Institute and consisted of three paper sacks containing 112 lb. each of sheet and three standard cases containing 224 lb. each. The type of paper sack used in this experiment is no longer recommended by the suppliers. The dimensions when sealed were approximately $13 \times 12 \times 30$ in., which are inconvenient for estates generally.

The new bag, the dimensions of which are $19 \times 9\frac{1}{2} \times 24$, is exactly half the size of a standard case (viz. $19 \times 19 \times 24$ in.). Each bag is now supplied in two equal sections which fit over each end of 1 cwt. of rubber compressed in the usual moulds with a plate to separate the rubber into 1 cwt. lots. The overlap of the two sections of the bag is secured with an adhesive paper strip. To open the package for sampling it is necessary to pull a red stitch which releases the sewing at one end. The sack is resealed with a strip of adhesive tape.

Although the old type of paper sack had unsuitable dimensions and was supplied in one piece the experiment was of value since

it afforded an indication of the suitability of paper sacks generally. The samples received were as follows:—

Paper Sack	Cases	Treatment
A	AX	Every sheet dusted with a mixture of one part zinc stearate and two parts magnesium oxide
B	BX	Outer wrapper sheets only dusted with powder
C	CX	No dusting

On arrival in London the rubber was examined by representatives of a London Wharf, the makers of the paper sacks, and a small rubber manufacturer in addition to the Committee's staff.

The sack (A) was torn on the top side exposing the rubber wrapping sheet over about one sixth of the area of the side, the sack (B) contained a small tear (about 2 sq. in.) on one side only, and the third sack (C) was in good condition.

Each paper package retained its original shape, and compared very favourably in this respect with rubber baled in hessian received in a previous consignment; this is probably due to the fact that the paper sacks were not subjected to such heavy pressure during transit as the bales.

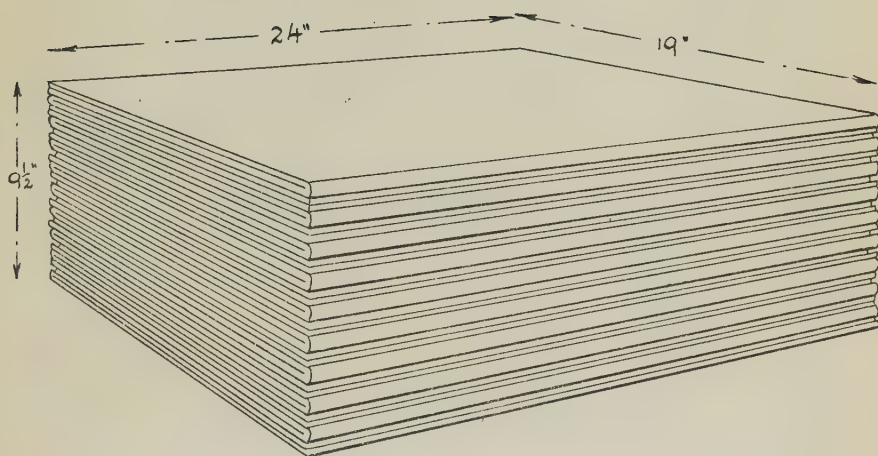
The wooden cases were all in good condition. The four battens at the upper edges of each case were nailed to the sides of the case and not to the edges of the cover as recommended by the Rubber Research Institute.

Previous information from the makers indicated that a given weight of rubber occupied about 8 per cent greater volume in a sack than in a case, but the dimensions of the sacks received showed that the volume of 112 lb. of rubber was slightly less than that of half a case.

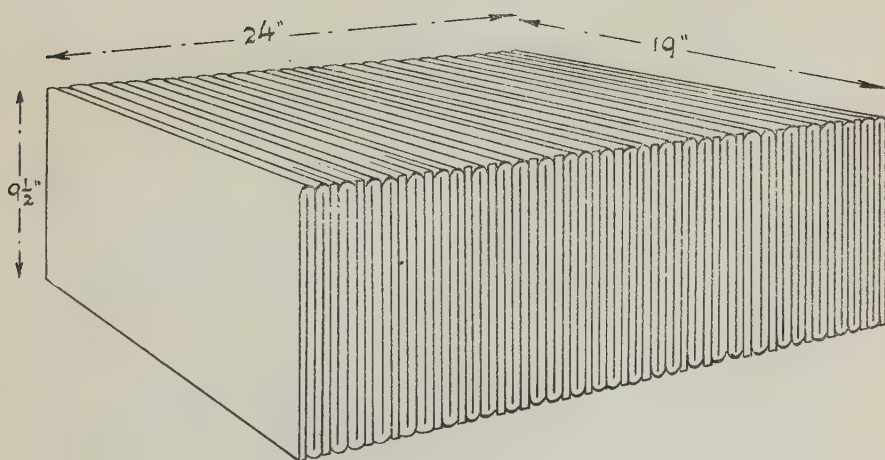
As regards ease of sampling there was little difference between the rubber in the cases and that in the paper bags. The dusting powder greatly facilitated the separation of the individual sheets but the appearance of the powder was strikingly similar to that of mould, which might prejudice the sale of the rubber on the open market. The dusting of the wrapping sheets only did not offer any advantage beyond ease of removal of the wrapper. A rubber manufacturer who had previously requested that rubber sheets should be dusted examined the consignment and was impressed by the ease with which the dusted sheets could be separated.

After opening the rubber and taking a sample from the centre in accordance with the practice of London wharves it was found

A.



B.



impossible to compress the whole of the contents into the sack again. The difficulty was accentuated by the large number of wrapping sheets employed and by the fact that they were placed in a transverse direction so that it was necessary to remove the wrapping sheets completely before sampling the rubber.

The second experiment comprised about 500 packages each containing 1 cwt. of smoked sheet in the latest type of sack and was organised by a member of the Rubber Growers' Association. The rubber was shipped to Amsterdam and then transhipped to London. The removal of the rubber to a barge was inspected in London and it was obvious that the paper sacks were much more easily handled than the cases by the dock labourers. Only one package appeared to be damaged beyond repair, although an estimated 5 per cent had minor cuts or tears.

The sampling of the rubber at a London Wharf was carried out in the presence of representatives of the Rubber Growers' Association, various rubber dealers, the makers, the technical press, and the staff of the London Advisory Committee.

The packages were easily opened by pulling the thread running along one end. Some of the rubber appeared to have been dusted on the outside with talcum powder, and was easily and cleanly removed from the packages. Those which were not dusted adhered to the paper package and were more difficult to remove. In the case of these packages it was claimed that the adhering pieces of paper could be easily removed by washing but the general experience of the staff of the London Advisory Committee indicates that considerable difficulty is entailed.

The rubber was not wrapped with wrapping sheets, which are desirable in case the paper sack becomes torn and dirt has an opportunity of penetrating between the sheets.

The sheets were more difficult to separate than rubber packed in cases. This method of packing would therefore not be popular with the wharves and with some of the smaller rubber manufacturers. It was stated however that the difficulty of sampling was due to the arrangement of the sheets which had been placed sheet upon sheet instead of end on as indicated in the diagrams opposite.

The effect of packing as in A is to compress the sheets more tightly together during transit and increase the tendency to mass. It is probable that packing as in B would reduce this tendency, in which case the principal objection to the use of paper sacks would be eliminated.

After separating the sheets and removing samples, the rubber was easily replaced in the paper sacks, which were quickly resealed.

It is evident from this experiment that the paper sack, which costs 10d. for two as compared with 1/8d to 2/0d for a wooden case, is a promising container for sheet rubber. It is desirable however to wrap the rubber with rubber wrapping sheets, to dust these on the outside with a surface lubricant and to place the rest of the sheets "end on". Apart from price the chief advantage of the paper sack is the absence of splinters and fibrous materials which tend to work their way into the mass of the rubber when it is packed in wooden cases or bales.

The third experiment consisted of four packages of baled sheet and one in a standard wooden case as follows:—

Package No	Type of package
1	Mengkuang matting strapped with metal bands
2	Hessian " " " "
3	Gunny " " " "
4	Strapped with metal bands only
5	Wooden case

On arrival in London the rubber was examined by representatives of one of the London wharves and of a rubber manufacturer who had previously expressed interest in baled rubber, and by the staff of the Committee.

Of the three matting materials the hessian and gunny were in good condition but the mengkuang was torn and frayed at some of the seams. All the rubber was wrapped with wrapping sheets apparently dusted with a surface lubricant which prevented the adhesion of fibrous material to the rubber. The wrapping sheets failed to cover the contents completely so that the inside sheets were exposed at the ends of the bales.

Considerable difficulty was experienced in sampling the baled rubber owing to the massing which occurred below the metal straps.

No difficulty was experienced in sampling the contents of the wooden case, but the rubber contained a considerable number of splinters which had penetrated beyond the wrapping sheets into the interior of the rubber. For this reason the rubber manufacturer's representative emphatically preferred the baled rubber. He considered that the mengkuang matting covering was the most suitable as there was more danger of fibrous material penetrating into the rubber when covered with hessian or gunny.

The rubber without covering was in a satisfactory condition, apart from the difficulty of sampling, but it is unwise to draw general conclusions from a single bale. Considerable experience with this method of packing would be required before it could be definitely approved.

The principal conclusion from the experiment is that most manufacturers would probably prefer baled rubber to rubber packed in cases but sampling constitutes a serious difficulty for baled rubber sold on the open market.

General Conclusions

(1) Paper sacks are promising containers for rubber. They have the advantage of cheapness, cleanliness and ease of handling, but it is necessary to ensure that the wrapping sheets are dusted with a surface lubricant and it yet remains to be shewn that when the sheets are placed in the package as suggested they will not mass under adverse conditions.

(2) Most manufacturers would probably prefer baled rubber to that packed in chests owing to the absence of splinters in the former. Mengkuang matting is probably cleaner than gunny or hessian, but it is necessary to dust the surface of the wrapping sheets to prevent the adhesion of fibrous materials. The use of metal straps with baled rubber causes the rubber to be extremely difficult to separate into individual sheets for sampling. The wharves and some of the smaller manufacturers therefore do not favour this method of packing.

(3) The dusting of individual sheets with a surface lubricant markedly improves ease of separation, which is an advantage to the wharves and to some of the smaller manufacturers. In some cases the lubricant eventually assumes an appearance similar to that of mould and this might prejudice the sale of the rubber on the open market. In reply to a suggestion by the Committee that the difficulty might be overcome by marking the cases so as to indicate that the rubber had been dusted with a named material, the Rubber Trade Association state that a buyer desiring to receive rubber dusted in this manner should stipulate accordingly when making a contract.

G. MARTIN
W. S. DAVEY

Imperial Institute
South Kensington, S.W.7
21 June, 1934

Appendix "B"

INSTRUCTIONS FOR BALING, PACKING AND SEALING SMOKED SHEET RUBBER IN 1-CWT. PAPER SACKS

(1) *Shape and Capacity.*—It will be noted that the shape and capacity of our 1-cwt. paper package when sealed is exactly half the size of the $19 \times 19 \times 24$ standard case, namely $19 \times 9\frac{1}{2} \times 24$. Thus, for shipping purposes the cubic capacity of two of these 1-cwt. packages is the same as the present standard 2-cwt. case.

(2) *Method of baling Rubber before packing.*—It is anticipated that the existing moulds now in use on the estates can be adapted and utilised for the method applicable to packing our 1-cwt. sacks as follows:

- (a) The mould used for packing a case $19 \times 19 \times 24$ would require to be fitted with a division plate to produce two bales $19 \times 9\frac{1}{2} \times 24$.
- (b) The rubber sheets are folded and compressed directly into the moulds. The baled rubber is then removed in two sections from the moulds and packed into 1-cwt. paper sacks as hereinafter described.
- (c) To remove the rubber bales from the mould it would probably be necessary to provide for one of the sides of the mould, as well as the division plate, to be removable. Actually it is possible to dislodge the bales from a mould laid on its sides (which is not fitted with a bottom) by hammering on one end of each of the bales.
- (d) Immediately the bales are removed from the mould they must be packed. This packing should be effected promptly before any appreciable expansion of the rubber occurs.
- (e) The next operation is to pack each 1-cwt. bale into the paper sack, and this is extremely expeditious and simple. The 4-ply sack is made in two sections of exactly the same size and shape to conform to that of the rubber bale, each of which is fitted over either end of the bale. Each section is made sufficiently long to provide for a 6 in. to 8 in. overlap, so that the end of each sack fits well over that of the other. The overlap of the two sections is then secured with any suitable "Latex" adhesive, and finally the seam is covered and protected with strong gum tape.

(3) A novel feature of this type of sack is that each end is sewn with a chain stitch, the running end of the under-thread being coloured red. To facilitate opening of the package for sampling purposes at port of discharge, it is only necessary to pull this red stitch which releases the sewing. To re-seal, a strip of strong gum tape can be used. As it is only a matter of sticking and holding in position the pre-folded end of the sack, this method of sealing will be found very effective and sufficiently strong for the final transport of the package to the buyer's warehouse.

BOOK REVIEW

"Chimie et Technologie du Latex de Caoutchouc" BY GEORGES GENIN (*Revue Generale du Caoutchouc* 1934, pp. ii + 392). In this book the author has described latex and its industrial applications. The book is divided into two parts of which the first and shorter covers the history, the source and means of obtaining latex, its composition and properties, the theories and technique of coagulation, the means of preservation and artificial concentration, together with the shipment of latex.

The second and larger section of the book describes the technique of latex compounding and the various processes to which a suitably compounded or prepared latex have been applied. Applications such as the dipping processes, the impregnation of fibres and fabrics, the manufacture of latex thread, the electrophoretic deposition of rubber, the preparation of sponge and micro-porous rubber, artificial leather and latex-bonded materials are described, together with other uses such as the application of latex to the manufacture of paper, rayon, paint, adhesives, footwear, and insulating materials. The possible application of latex to roadways is also discussed.

The author has made an extremely comprehensive and up-to-date survey of the literature; full references are given and the subject matter, unlike that of the recent book of similar scope by Marchionna, is presented not in the form of separate abstracts but in the more orthodox narrative form. References to publications which appeared as late as 1933 are frequent and it is noticeable that the author has drawn upon the publications of the Rubber Research Institute to a much greater extent than did Marchionna. The form of the book, together with a large number of drawings and illustrations will make it particularly acceptable to those whose general knowledge of latex processing and manufacturing technique is somewhat sparse; it presents a series of clear descriptions of the manner in which the various operations are performed.

There are a few minor errors in the names of certain authors and the book would have been much improved by the inclusion of complete indexes, but it nevertheless constitutes an extremely useful addition to the literature on latex and latex technology.

E. R.

Kuala Lumpur,
17th October, 1934

